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Exploration camp of the Miner River Resources/Eagle Plains Resources joint venture on the Greenland Creek property in the Purcell Mountains, 30 kilometres north of Kimberley.

FOREWORD

The total exploration expenditure in British Columbia in 1998 is estimated at between $35 million and $40 million, a dramatic reduction of approximately 50% from the $75 million total in 1997. Four of the five regions experienced sharp reductions ranging from 24% in the Kootenay region to 77% in the South-Central region. Only the Southwestern region reported an expenditure level which was roughly the same as in 1997, although two-thirds of the total was spent on one project, mine-site exploration at Myra Falls. Similarly, in the Northwest region, one company, Homestake Canada Inc. working in the Eskay Creek area, accounted for 45% of the total expenditure and 55% of the total drilling recorded in the region. Of the provincial expenditure total, it is estimated that only about 10% was on grassroots or generative projects, a situation of significant concern that has shown no improvement since 1997. About 33% was spent around minesites and the remainder on advanced projects. All five regions reported major reductions in the amount of exploration drilling, the provincial total being estimated at approximately 170 000 metres, 58% less than the 407 000 metres recorded in 1997.

Although all statistical indicators confirm that 1998 was a very bad year for exploration in British Columbia, the situation was not unique to this province. Low metal prices, coupled with the Asian economic crisis, resulted in abnormally restrained investment in mining exploration and development worldwide. To help ensure a viable mining industry in the long term, the British Columbia government introduced the BC Mining Initiative during 1998, which is designed to encourage and assist exploration and to improve the climate for secure mining investment in the province. This initiative includes a *Mining Rights Amendment Act*, which assures access to mineral tenures, promotes fair compensation for tenure expropriation for park creation and confirms the right to mine new discoveries, and a new Mineral Exploration Code, intended to create a one-window approach to permitting. A Mining Exploration Tax Credit was introduced, effective August 1, 1998, which provides a refundable tax credit of 20% on qualified exploration expenditures. Reviewability thresholds under the *Environmental Assessment Act* were raised and streamlined in order to simplify and accelerate development approvals of new mine projects. Continuation of the Prospectors Assistance Grant Program and field activities of the Geological Survey Branch, particularly in frontier areas with recognized high mineral potential, were among several other programs designed to spur grassroots exploration leading to new mineral discovery.

The value of solid mineral production in 1998 is estimated at about $3 billion, a decrease of 4.8% from 1997, mainly due to lower commodity prices, especially for coal. The loss of production due to lower prices was partly offset by the opening of the Kemess South gold-copper mine, the re-opening of the Blackdome gold-silver mine, achievement of full production levels at the Huckleberry and Mount Polley copper mines, and increased silver-gold production at Eskay Creek. Only one mine, the QR gold mine, closed during 1998. However, the Gibraltar copper-molybdenum mine stopped mining and milling in December with full closure expected early in 1999. Mine Development Certificates were issued under the Environmental Assessment Act to the Tulsequah Chief polymetallic mine and to the Willow Creek coal project. The Silvertip silver-lead-zinc project near the Yukon border entered the Environmental Review process and reviews continued on the Prosperity, Getty North, Red Chris and other projects

Favoured exploration targets in 1998 continued to include precious metal and polymetallic veins, copper-gold porphyries and skarn/manto deposits. However, polymetallic massive sulphide deposits became, for the first time in many years, the most favoured targets accounting for about 37% of the total expenditure. Leading the way were major programs in the vicinity of the Myra Falls and Eskay Creek mines. Other major programs of interest included ongoing definition drilling by Taseko Mines Ltd. at the Prosperity porphyry gold-copper deposit, deep drilling and metallurgical testing by Misty Mountain Gold Ltd. at the Specogna epithermal gold deposit on Graham Island and drilling by Kennecott Canada Exploration Inc. for Sullivan-type sedex mineralization on the Findlay project in the Kootenays.

Part A of this publication contains a review of exploration and mining highlights in each of the five regions, contributed by the Regional Geologists in Smithers, Prince George, Vancouver, Kamloops and Cranbrook. The regional reviews are preceded by a provincial overview paper contributed by Tom Schroeter of the Vancouver Mineral Development Office. Part B of the publication contains several geological descriptions of specific properties. Final compilation and preparation of the volume for publication was carried out by Bob Lane, Regional Geologist in Prince George, with the assistance of Dorthe Jakobsen of the Geological Survey Branch and after thorough editing by external editor, John Newell.

Paul Wilton
Regional Geologist
Cranbrook

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PART A

OVERVIEW OF EXPLORATION ACTIVITY

BRITISH COLUMBIA
1998 MINERAL EXPLORATION REVIEW

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INTRODUCTION

The opening of the **Kemess South** porphyry gold-copper mine, in the Toodoggone district, highlighted metal mine developments in 1998. The capital cost of the project, including a new 380 kilometre, 230-kilovolt electric transmission line, was $480 million. The improved infrastructure is expected to result in increased exploration in the region. The **Blackdome** gold-silver mine re-opened in November after a seven year hiatus in production. Project Certificates under B.C.'s Environment Assessment were issued during the year to the **Tulsequah Chief** and the **Willow Creek** mine development projects.

Exploration expenditures in 1998 are estimated to be approximately $40 million. The number of mineral and placer claim units recorded in 1998 is approximately 18 600. Figure 1 illustrates the fluctuation of expenditures and recordings of mineral units between 1971 and 1998. Drilling in 1998 is estimated to total 170 000 metres.

There were a significant number (approximately 12) of new mineral discoveries reported throughout the province in 1998. Most have been made by prospectors and many can be attributed to improved access afforded by construction of new logging roads.

Several bulk-sampling projects were carried out (*e.g.* **Willow Creek, Kaslo Silver and Blu Starr**). A number of advanced projects are in the Environmental Assessment Process (*e.g.* **Silvertip (Midway), Red Mountain, Bronson Slope, Getty North, Telkwa, Red Chris and Prosperity**). Custom milling facilities exist at a number of sites (*e.g.* **Roberts** mill at Greenwood and **Ainsworth** mill at Ainsworth), and a new mill at Salmo was under construction to heap leach gold from the **Arlington** and **Ymir** deposits.

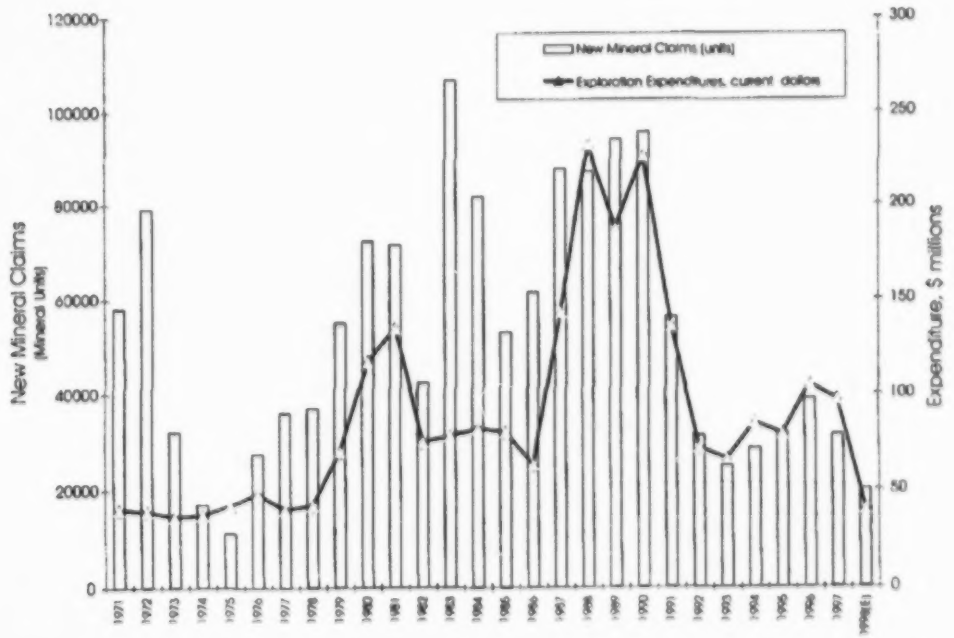

Figure 1. Mineral exploration expenditures and number of new mineral claims recorded in B.C. 1971 - 1998 (Data source: MEM, Minerals, Oil & Gas Branch and Mineral Titles Branch).

Exploration targets in 1998 were varied and the distribution of exploration dollars by target type is illustrated in Figure 2. The biggest change in exploration focus in 1998 has been an increased emphasis on massive sulphide deposits. Massive sulphides (37%), particularly sedex and seafloor hydrothermal types have taken over from vein deposits (22%) as the most favoured target in 1998.

Approximately 33% of exploration expenditures was around minesites, including $3.65 million at coal mines. An estimated 57% of exploration expenditures was on established or previously drilled properties, and 10% of expenditures was for grassroots/generative programs (Figure 3). Figure 4 illustrates the fluctuation of estimated percentage of exploration expenditures by category of program between 1994 and 1998.

There were approximately 70 exploration projects with budgets in excess of $100 000. Four projects had budgets over $1 million and accounted for approximately 30% of the total. The largest program was by Westmin-Boliden Ltd. at its **Myra Falls** mine on Vancouver Island. The three other expenditure projects in excess of

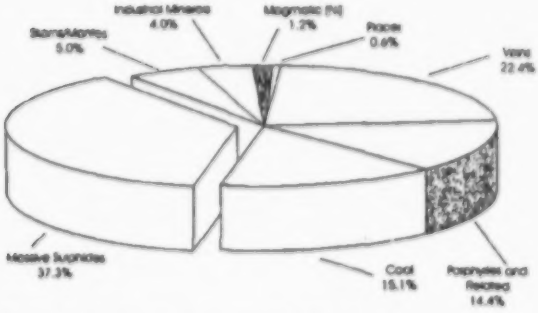

Figure 2. Exploration targets - 1998; by deposit type.

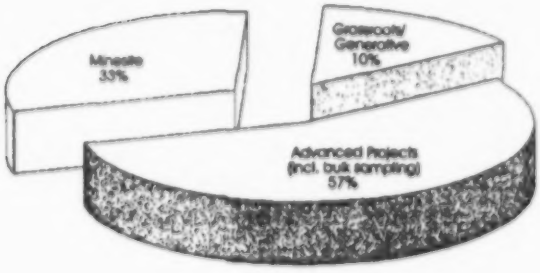

Figure 3. Exploration targets - 1998; by level or category of program.

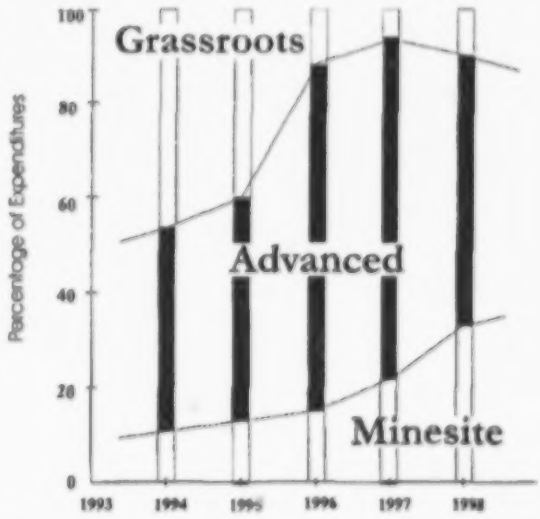

Figure 4. Estimated percentage of exploration expenditures; by level or category of program.

$1 million were: **Eskay Creek**, **Bull River** and **Fording Coal**. Grassroots programs were carried out in:

- the south-central (**Interior Plateau**) and northwest (**Toodoggone**) areas for bonanza and bulk-mineable epithermal gold deposits;
- the Quesnel Trough (**Cariboo** to **Toodoggone** areas) for gold-enriched porphyries; the southeast (**Sullivan**) area for sedex deposits;
- the northwest (**Eskay Creek** and **Tatsamenie Lake**) for precious-metal rich seafloor hydrothermal deposits, and Carlin-type and/or transitional gold deposits;
- numerous areas throughout the province in the search for gemstones.

Kennecott Canada Inc. drilled the **Findlay Creek** and **Irishman Creek** sedex targets in the southeast, located north and south of the Sullivan mine, respectively. Although results have not been reported, several new claims were recorded in the area and several other properties await drilling. Dia Met Minerals Ltd. completed one deep drillhole on its **Paul-Mike** sedex target south of Wasa. Hudson Bay Exploration and Development Co. Ltd. conducted small ground follow-up programs on several claim blocks it staked to cover geophysical anomalies in the Babine country in 1997. Homestake Canada Inc. carried out both detailed and regional exploration programs around the Eskay Creek mine and along strike on favourable host stratigraphy. It also examined other areas in the northwest for **Eskay Creek**-type mineralization. Cominco Ltd. conducted exploration for sedex and/or replacement deposits in the southeast. Rio Algom Ltd. undertook both property

examinations and a grassroots program in the central part of the province.

The Government of British Columbia introduced a Mining Exploration Tax Credit in 1998 to assist grassroots exploration in the province. Effective August 1, 1998 exploration expenditures made by eligible individuals and corporations in British Columbia qualify for a refundable credit of 20% of qualified expenses for the taxation year.

MINING HIGHLIGHTS

The value of solid mineral production for 1998 is estimated at $3.006 billion (Table 1). The value of metal production is about 2% lower than in 1997, and lower commodity prices, particularly for coal, resulted in an overall decrease in value of 4% from the previous year (Figure 5).

The locations of the fourteen metal, eight coal, ten industrial minerals mines and one tailings project that were in operation in 1998 are indicated in Figure 6. There were two new metal-mine openings (**Kemess South** and **Blackdome**) and one metal-mine closure (**QR**) during the year.

Despite full production from the **Huckleberry** and **Mount Polley** porphyry copper mines, which opened in late 1997, together with opening of the **Kemess South** porphyry gold-copper mine in the spring of 1998, there was a slight decrease in the value of copper production. The devaluation of the Canadian dollar also contributed to this increase. As in 1997, significant increases in silver and gold production from the **Eskay Creek** mine contributed to an increase in the value of silver production and helped offset the loss from the closure of the **QR** mine in March 1998 and the 18-year low gold price

Clean coal production in 1998 is expected to total about 25.3 million tonnes, with a forecast value of approximately $1.087 billion, or approximately 36.2% of the total solid mineral production. The reported value is at the mine mouth and does not include rail and port costs, which are paid by the customer.

The forecast value of structural materials at approximately $404.3 million, and of industrial minerals at approximately $49.9 million, represent slight increases from 1997. There are approximately 1100 construction aggregate operations and 40 industrial minerals mines in the province.

The number of direct mining employees in British Columbia in 1997 was estimated at approximately 12 750, the highest level since 1992. This number should remain the same in 1998 due to the 350 and 80 new employees at **Kemess South** and **Blackdome**, respectively, netted against the decrease resulting from mine closures and cutbacks.

Copper represents 22.7% of total production value, at a projected $681.3 million, a 2.5% decrease from 1997. Gold production is forecast to be 21.7 million grams (697 671 oz) valued at $304 million, up by about 15% from 1997. These increases are primarily the result of increased production of gold from **Eskay Creek**, **Mount Polley** and **Kemess South**.

Silver output is forecast at 451 million grams (14.5 million oz) valued at $118.8 million. The value is up about 15% from 1997, primarily as a result in increased

TABLE 1. 1998 FORECAST VALUE OF SOLID MINERAL PRODUCTION IN B.C.

Commodity	Quantity (millions)	C$Value (millions)	Percentage Total Value
Gold	21.7g	303.9	10.1%
Silver	451g	118.8	4.0%
Copper	277.1kg	681.3	22.7%
Lead	31.3kg	24.4	0.8%
Zinc	153.6kg	231.4	7.7%
Molybdenum	7.6kg	82.4	2.7%
Other Metals		21.4	0.7%
Total Metals		**1463.6**	**48.7%**
Metallurgical Coal	23.7t	1042.5	34.7%
Thermal Coal	1.6t	45.4	1.5%
Total Coal	**25.3t**	**1087.9**	**36.2%**
Industrial Minerals		49.9	1.7%
Structural Materials		404.3	13.4%
Total Solid Minerals		**3005.6**	**100.0%**

NOTE: Prices are F.O.B. for metals only
Source: MEI Stats. & NRCan (Feb 3, 1999)

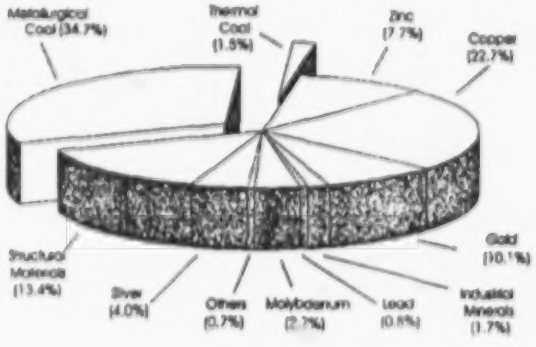

Figure 5. Forecast value of solid mineral production in British Columbia; by percentage of total value - 1998 (Data source: MEM; Minerals, Oil & Gas Branch).

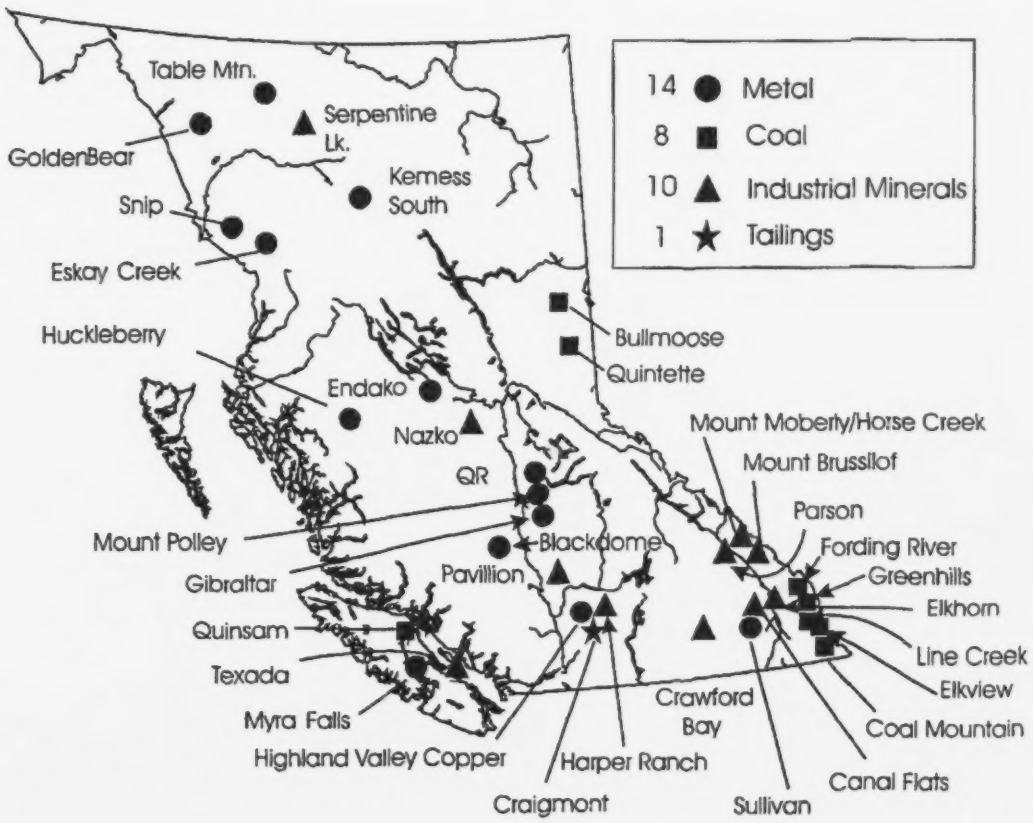

Figure 6. Operating mines in British Columbia - 1998.

production from **Eskay Creek** and a higher price. Zinc production in 1998 is forecast to be 153.6 million kilograms worth $231.3 million and lead output is forecast to be 31.3 million kilograms valued at $24.4 million. These figures represent decreases in value of 20% for zinc and 39% for lead from 1997.

Many mines had significant exploration programs, some with good results. In particular, at the high-grade **Eskay Creek** gold-silver mine and at the **Myra Falls** zinc-copper mine.

EXPLORATION HIGHLIGHTS

METALS

It is estimated that 1998 expenditures on advanced projects and on grassroots projects accounted for 57% and 10% of total expenditures, respectively. The **Bronson Slope, Red Chris, Red Mountain, Silvertip (Midway), Telkwa, Prosperity** and **Getty North** projects are in the Environmental Assessment Process. Several other advanced projects are nearing entry to the Environmental Assessment Process (*e.g.* **Cariboo Gold Quartz, Giant Copper, Specogna, Hearne Hill/Morrison, Isk, J & L, Bull River** and **Polaris-Taku**) (see Figures 7a, 7b and 8).

The most active area in the province was the Southeast, where numerous companies and prospectors explored for massive sulphide deposits (*e.g.* Kennecott's work on the Findlay Creek project). In the rest of B.C. many programs were focused around areas with mines, and throughout the province there were several new, low-budget regional programs.

MASSIVE SULPHIDE DEPOSITS

Base and precious metal rich (sedex, volcanogenic and seafloor hydrothermal) massive sulphide deposits were important exploration targets in 1998. The exploration successes at **Myra Falls, Tulsequah Chief** and **Eskay Creek** over the past few years testify to the excellent potential for these deposit types. The

discoveries of the Wolverine and Kudz Ze Kaya deposits in Yukon-Tanana Terrane in the Yukon, and the successful re-opening of the Greens Creek mine west of Juneau, Alaska, are reminders that the rocks which host these deposits extend into British Columbia.

The largest exploration program in 1998 was at the **Myra Falls** underground mine. The mine has produced in excess of 20 million tonnes of ore since start-up in 1966, from a number of different orebodies defined along a 6-kilometre long northwest trend, and has ore reserves sufficient for a further seven more years of production. Early in 1998 Boliden Limited took over the operation from Westmin Resources Limited; the new company is named Boliden-Westmin Ltd. In 1998 the company drove a 700-metre crosscut on the 10 level in the Lynx mine to provide drill stations to test for the western extension of the Marshall zone. While driving the crosscut, a series of underground drill holes intersected significant concentrations of barite and massive sulphides in rhyolite at the same stratigraphic level as the Marshall zone, but approximately 600 metres along strike to the northwest. The company is encouraged by these results; it believes the style of mineralization is similar to that found in the high-grade, precious metals rich Gap deposit (and approximately 40 metres above the Battle zone ore). The barite intercepts contain the highest gold and silver values encountered on the property. The target, currently being tested by steeper holes from the end of the drift, is approximately 700 metres below 10 level. A major drilling program is planned in 1999. Elsewhere on the property, the company carried out a deep-penetrating electomagnetic geophysical survey under Phillips Ridge, and conducted surface diamond drilling from Myra Ridge and from the valley floor to test for extensions of the Trumpeter West mineralization. In mid-November, it announced it will temporarily close the mine between December 1998 and April 1999, for underground rehabilitation work. About 90 of the 450 employees will be affected.

Prime Resources Group Inc. (now 100% controlled by Homestake Canada Inc.) outlined significant new resources in the 21C zone to the west of the main **Eskay Creek** ore zone (21B), the 21A zone to the south and the Pumphouse zone to the east. The 21C zone, 200 metres west of the 21B zone, consists of auriferous pyrite hosted in rhyolite, approximately 40 metres below the mudstone contact. A resource calculation for the 21C zone is in progress. Elsewhere on the property, Prime tested a number of zones along strike to the south of the 21B zone, including the drilling of five deep (>1500 metres) holes in an area near the Mackay adit and along strike to the south, testing the favourable host stratigraphy.

In March 1998, Redfern Resources Ltd. received a Project Certificate for its **Tulsequah Chief** polymetallic volcanogenic massive sulphide project. Reserves estimated by the company are 7.9 million tonnes grading 6.35% Zn, 1.27% Cu, 1.18% Pb, 2.42 g/t Au and 100.91 g/t Ag. At full production, milling 900 000 tonnes per year, the mine is forecast to produce 52 620 tonnes of zinc, 10 450 tonnes of copper, 4940 tonnes of lead, 81 000 kilograms (2.6 million oz) of silver and 1910 kilograms (61 400 oz) of gold annually over a minimum mine life of twelve years. The capital cost of the project is estimated at $160 million; the operation would employ 265 persons. Access is proposed via a 160-kilometre restricted road from Atlin. Redfern has begun the permitting process for road access, but has, to date, been unsuccessful in raising approximately $2.5 million for a follow-up underground definition drilling program.

In June 1998, Weymin Mining Corporation contracted H.A. Simons Ltd. to provide a review of the previously completed metallurgical process options, to estimate the capital and operating costs and to determine the economics of its **J & L** (McKinnon Creek) massive sulphide deposit near Revelstoke. Two options are being considered. The first contemplates all processing taking place at the mine site. The second would involve mining and a heavy media separation stage at the site and subsequent processing at an off-site facility. The capital cost of the first option would be $82 million; the second would be $115 million. Weymin estimates a resource of 3 600 000 tonnes grading 3.0% Zn, 3.0% Pb, 81 g/t Ag and 7.24 g/t Au in its Main zone and 1 000 000 tonnes grading 7.1% Zn, 2.5% Pb and 52.5 g/t Ag in its Yellow Jacket zone. The company proposes to conduct further drilling to increase the current resources. It is looking for a joint venture partner to assist in the development of this project. In 1998, due to the difficulty in raising funding, only a minor prospecting program was carried out.

Several sedex targets were explored in the search for a Sullivan-type deposit in the Purcell Basin of southeastern British Columbia. At the **Findlay Creek** property, Kennecott Canada Exploration Inc., under a joint venture agreement with Eagle Plains Resources Ltd. and Miner River Resources Ltd., completed five diamond-drill holes totaling approximately 1850 metres. The property, 35 kilometres northwest of the Sullivan mine, covers the same stratigraphic sequence which hosts this world-class deposit. The most significant mineralization was encountered in the last hole, collared on Tourmalinite Ridge. The mineralized interval was intersected well above the Sullivan-horizon, indicating potential for the discovery of mineralization elsewhere in the stratigraphy. The 1998 field program also included detailed geological mapping, contour geochemical soil sampling and prospecting. The **Greenland Creek** property adjoins the Findlay Creek property to the south and is underlain by a similar sequence of prospective rocks. In mid-November, Kennecott announced the signing of a letter of agreement on this project. At the **Irishman Creek** sedex property, under option from Sedex Mining Corp., Kennecott, drilled a 350-metre

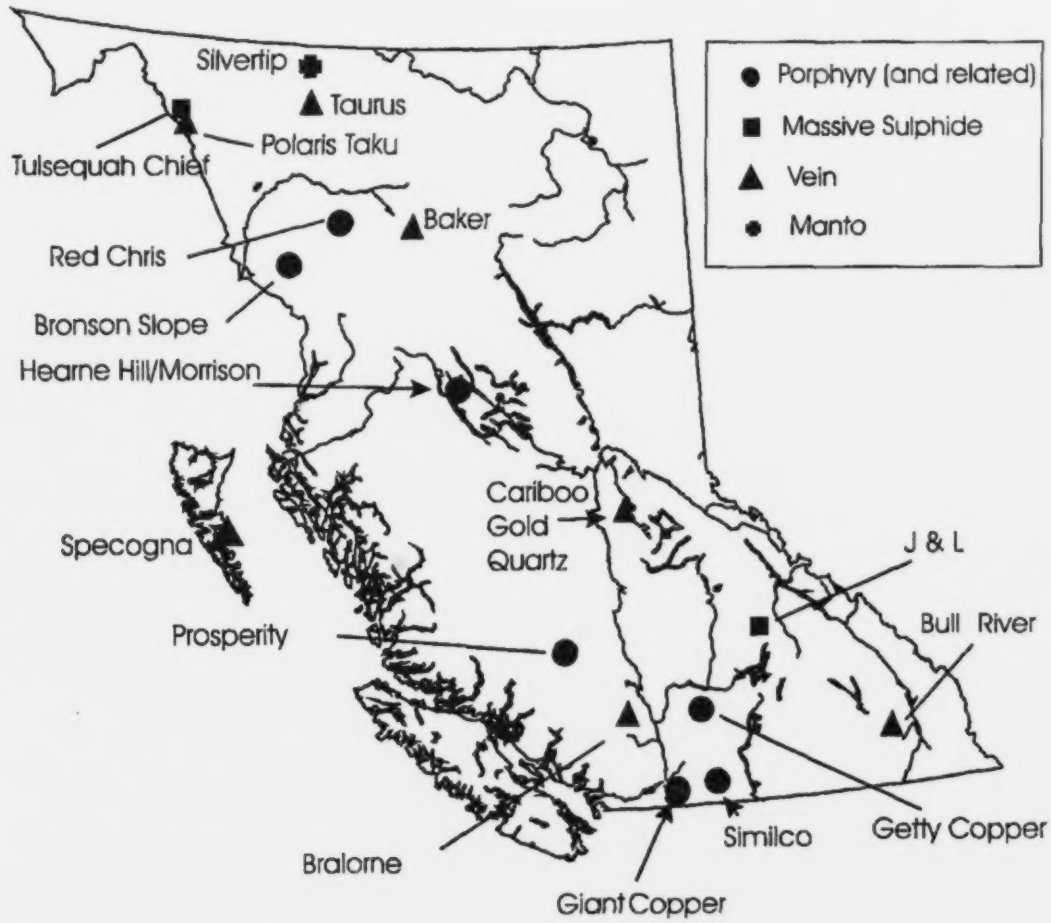

Figure 7a. Advanced projects - Metals, 1998.

extension of its third hole drilled in 1997 on the Panda vent system. The objective was to test a re-interpreted position of the Sullivan horizon.

At the **Corey** property, 15 kilometres south of the high-grade Eskay Creek gold-silver mine, Homestake Canada Inc., under an option agreement with Kenrich Mining Corporation, completed a program of detailed mapping and sampling over the southwestern part of the PRU block as part of its testing of the 12 kilometres of prospective Eskay Creek stratigraphy. Homestake drilled four holes totaling approximately 1260 metres in the Cumberland South area. Elsewhere on the Kenrich block, Kenrich conducted a limited program on the HSOV showing. Several other targets have been identified.

PORPHYRY (AND RELATED) DEPOSITS

Between 1991 and the fall of 1998, Taseko Mines Ltd. completed 127 330 metres of drilling in 271 holes on its **Prosperity** (formerly Fish Lake) porphyry gold-copper deposit. Including all previous companies' drilling, a total of 154 330 metres of drilling had been completed in 447 holes. Independent Mining Consultants, Inc. has calculated a mineable mineral reserve of 633 million tonnes grading 0.253% Cu and 0.466 g/t Au. Pilot plant metallurgical and process programs, including bulk sample testing of the deposit, completed by Lakefield Research Limited, have confirmed detailed process criteria. Independent is now completing a mine plan and a mine production schedule. In April 1998, Taseko received the final Project Report specifications from the Environmental Assessment Office and the company is

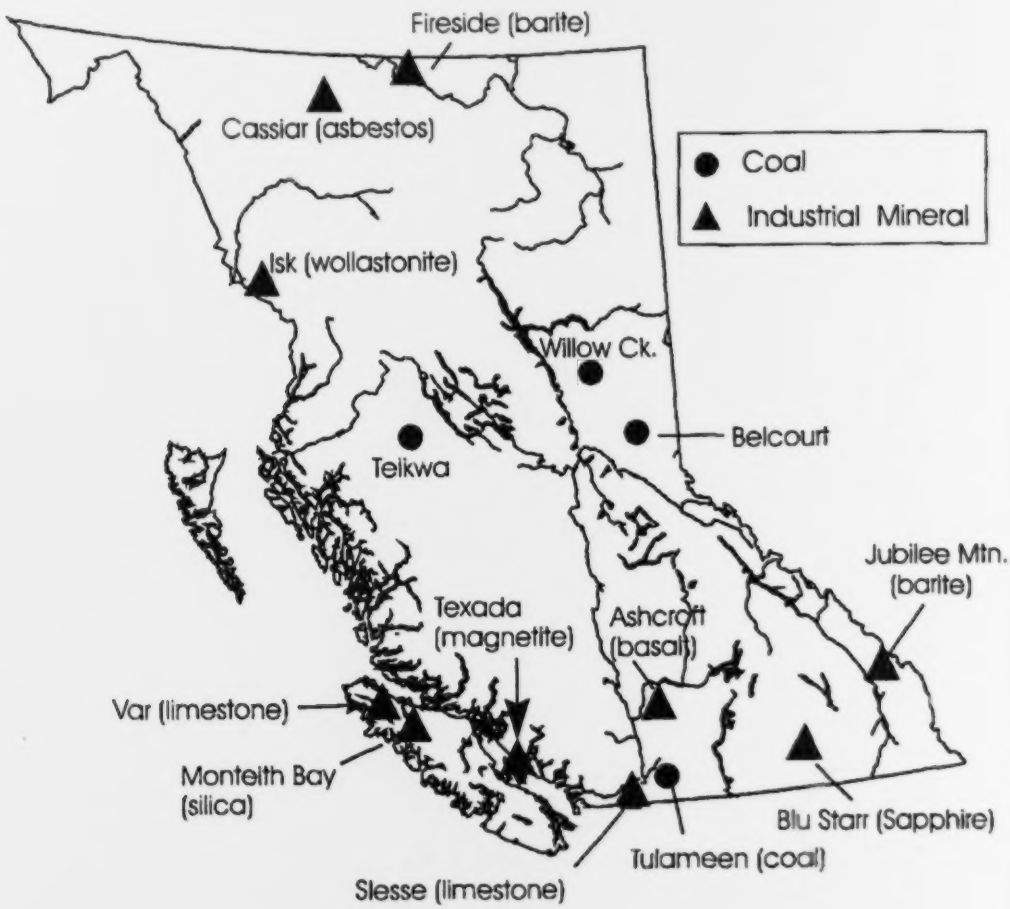

Figure 7b. Advanced Projects - Coal and Industrial Minerals, 1998.

preparing comprehensive environmental and socio-economic studies for presentation to the government Project Review Committee. At a projected 90 000 tonnes per day milling rate, the company forecasts annual production of 12 940 kilograms (416 000 oz) of gold and 95 795 tonnes (211 million pounds) of copper, over the 25.3 year mine life. Taseko commissioned SNC Lavalin and Kilborn Engineering to undertake a detailed feasibility study of the deposit. As part of this study, a major program of drilling commenced in November, designed to test geotechnical parameters and confirm the known reserve. A Project Report is expected to be submitted in mid-1999, following completion of the feasibility study. Taseko estimates capital costs of $600 million to bring the mine into production.

American Bullion Minerals Ltd. released the results of a new pre-feasibility study for its **Red Chris** porphyry copper-gold deposit in July 1998. In April, Giroux Consultants Ltd. estimated a new resource of 522.7 million tonnes grading 0.352% Cu and 0.272 g/t Au at a cut-off grade of 0.2% Cu. Furthermore, a company review has identified an "inner core" of 118.9 million tonnes grading 0.584% Cu and 0.470 g/t Au at the same cut-off. These grades exceed values assigned in the previous block model by 18.9% and 19.9% for copper and gold, respectively. American Bullion continued to refine a new strategy for development and mining of the deposit, using a method to take advantage of gravity and selective mining of the higher grade "inner core". The company is currently examining the project based on a 16 000 to 24 000 tonnes per day milling operation. No significant on-site work was carried out in 1998.

International Skyline Gold Corporation continued work towards the completion of a feasibility study of its **Bronson Slope** polymetallic porphyry property, adjacent to the Snip mine, and submission of a final Project Report

to the provincial government under the *Environmental Assessment Act*. A pre-feasibility study has identified a resource of 79 million tonnes grading 0.17% Cu, 0.48 g/t Au, 2.70 g/t Ag and 0.006% Mo. The project, as currently envisaged, is a 15 000 tonne per day milling operation; capital costs are estimated at $150 million. No significant on-site work was carried out on the property in 1998.

Getty Copper Corporation announced in January 1998 an updated resource estimate on its **Getty North** deposit of 72 million tonnes grading 0.3% Cu, including 10 million tonnes of oxidized material grading 0.4% Cu. Preliminary metallurgical studies have shown that leaching resulted in approximately 65% recovery of copper from the sulphide resource. The company is considering processing both the oxide and sulphide ore by SX-EW leaching technology. In the spring, Bateman Engineering conducted a review of available information regarding the Getty North deposit and recommended proceeding to a full feasibility study, after completion of pre-feasibility work. Getty applied for a bulk sample permit in order to obtain oxidized material for pilot leach testing. Stripping began in June in preparation for mining a 1500-tonne bulk sample. Due to difficulty in raising financing, the project was put on hold in July.

In the Babine camp, Booker Gold Explorations Ltd. completed a resource estimate for its **Hearne Hill** porphyry/breccia copper-gold deposit. It estimates a drill-indicated resource of 4 230 000 tonnes grading 0.60% Cu and 0.186 g/t Au, based on a 0.3% Cu cut-off grade, for the high-grade Bland and Chapman breccia zones. In late 1997, Booker concluded an option agreement with Noranda Mining and Exploration Inc. on the **Morrison** porphyry copper-gold deposit, which adjoins the Hearne Hill property to the north. Booker estimates a drill-indicated resource on the Morrison property of 123 200 000 tonnes grading 0.38% Cu and 0.203 g/t Au, based on a 0.3% Cu cut-off. Booker completed a very limited drilling program on the Morrison property in January 1998; the project was subsequently put on hold due to difficulty in raising funds. The company estimates a combined indicated resource for Morrison and Hearne Hill of 127 430 000 tonnes grading 0.39% Cu. The nearby Bell mine, closed since 1992, has remaining resources estimated at 70.4 million tonnes grading 0.44% Cu and 0.2 g/t Au.

Imperial Metals Corporation is conducting a feasibility study for a six-year, 1800 tonne-per-day open-pit and underground copper-gold-silver mining operation at its **Giant Copper** property, with milling at its Similco mine. It estimates a mineral resource of 45 373 026 tonnes grading 0.47% Cu, 0.38% g/t Au and 11.19 g/t Ag in the AM and Invermay deposits. In late 1997, the company filed an application to the government for a 10 000-tonne bulk sample permit. It hauled some material to its Mount Polley mill for metallurgical testing in 1998. As a result of depressed commodity prices and the difficulty in raising funds, this project was put on hold in 1998.

In early 1998, Imperial Metals Corporation merged with Princeton Mining Corporation. Its **Similco** copper-gold mine, which has been on standby since November 1996, has an estimated resource of 128 794 000 tonnes grading 0.397% Cu with gold and silver credits and potential for further expansion of resources. Imperial is evaluating a long-term plan involving the possible re-opening of Similco, including the possibility of milling ore from its Giant Copper property.

At the **Pine** porphyry gold-copper property in the Toodoggone district, approximately 22 kilometres north of the Kemess South mine, Stealth Mining Corporation continued drilling, focusing on the northwest side of the zone over an area approximately three kilometres long and one kilometre wide. The company postulates that the porphyry system has been influenced by a late-stage, gold-enriched event. Coincident geochemical and geophysical anomalies were outlined north of the Findlay River. The company is looking for a joint venture partner to continue exploration and development of this large property.

On the **Granite Mountain** porphyry copper property, north of the Gibraltar mine, United Gunn Resources Ltd. and Oakmont Ventures Ltd. conducted exploration on six separate grids. Two new areas containing significant porphyry copper mineralization were discovered. The Bysouth showing and the Rick showing are located 8.5 kilometres and 1.5 kilometres north and northwest of the Gibraltar mine, respectively. United Gunn completed preliminary I.P. surveys over these zones, prior to drilling planned in 1999.

In the Tulsequah area in the Northwest, Xplorer Gold Ltd. drilled eleven holes into the **Red Cap** copper-molybdenum porphyry system, which has a precious metals overprint. The company is testing the potential for a high-grade zone with sufficient gold, cobalt and silver values to support bulk-tonnage underground mining.

PRECIOUS METAL BEARING VEINS AND BULK-MINEABLE DEPOSITS

Epithermal and mesothermal vein deposits offer potential for both large tonnage, low-grade operations and lower tonnage high-grade deposits. For example, in November 1998, Prime Resources Group Inc. produced its one millionth ounce (31 100 kilograms) of gold from the high-grade **Snip** mine. The mine started production in 1991 and is scheduled to cease operating in the second quarter of 1999. It ranks as the eighth gold producer in the province historically.

At the **Specogna** (formerly Cinola) epithermal gold deposit, on Misty Mountain Gold Ltd.'s Harmony Gold property on Graham Island, Queen Charlotte Islands, a

metallurgical sampling program was initiated late in the season. In late 1997, a deep drilling program intersected intervals of the auriferous hydrothermal breccia, up to 53 metres wide, at depths of 400 metres. In addition, an induced polarization survey has outlined a strong chargeability anomaly extending 500 metres north from the Specogna deposit. The 1998 sampling program was designed to provide additional material (approximately 4 tonnes) for ongoing bio-oxidation testing. Based on 80 000 metres of drilling in 538 holes, and using a 1.2 g/t Au cutoff grade, the open-pit mine model provides for processing of 33.5 million tonnes grading 2.11 g/t Au, followed by processing of 19.2 million tonnes of stockpiled material grading between 1.2 and 0.8 g/t Au.

During 1998, Canarc Resource Corporation continued to search for a joint venture partner and other financing for its **Polaris-Taku** (New Polaris) gold project in the Tulsequah area. In 1997, due primarily to the Bre-X fiasco, Canarc lost the financing it needed to complete a feasibility study; it was approximately 60% complete at the time. The company currently estimates a resource of 3 270 000 tonnes grading 13.7 g/t Au. No on-site work was conducted in 1998 due to lack of funds.

Bralorne-Pioneer Gold Mines Ltd., in a joint venture with Avino Mines and Resources Ltd., continued to seek financing to put its **Bralorne** gold mine back into production. Existing geological resources above the 800 level (main haulage tunnel) are estimated by the company at 432 500 tonnes grading 10.63 g/t Au. Since 1995, when it received a Mine Development Certificate for the project, the company has discovered seven new veins, has conducted additional diamond drilling and nearly completed construction of a new gold recovery mill.

At the **Pellaire** (formerly Lord River) gold telluride deposit, in the Taseko Lakes area, International Jaguar Equities Inc. conducted a bulk-sampling and exploration program in 1998. A 1-tonne surface sample will be used to complete column-leach and metallurgical test work to assess the feasibility of a heap-leach operation. If this work has positive results, the company intends to include the construction of a pilot-scale (up to 10 000 tonnes) heap-leach test pad in its 1999 exploration and development program. Eleven surface and underground holes were drilled in 1998, testing the No. 3 and No. 5 veins. International Jaguar conducted a reconnaissance exploration program in the region, as well as a limited program of mapping, geochemistry and geophysics on the nearby Chita porphyry copper-gold target. The regional exploration program discovered a new porphyry copper showing, the Northwest Copper prospect.

In the Wells-Barkerville area, famous for both its lode and placer gold production, International Wayside Gold Mines Ltd. continued exploration on its **Cariboo Gold Quartz** mesothermal vein-gold property. In July 1997 the company estimated a mineral resource of approximately 3 million tonnes grading 3.5 g/t Au, at a cut-off grade of 1 g/t Au, above the 1200 level of the mine. During 1998, underground and surface drilling continued to test the Rainbow, Pinkerton and Sanders zones. The objective is to define a mineable open-pit reserve. In the fall, the company focused its exploration drilling on the BC vein, in an effort to outline underground pockets of higher grade mineralization. With the completion of the 1200-level exploration and development program, a contract was let to Geologic Systems Ltd. for a revised mineral resource calculation.

In the Toodoggone district, northwest of the recently opened Kemess South mine, Sable Resources Ltd. completed a modest drilling program testing the vein B extension, the West Cirque zone and the New Zone areas at the **Baker** mine. It also trenched an area north of the mined-out vein A, in an attempt to locate the source of a recently discovered high-grade float boulder. Sable also outlined approximately 8000 tonnes grading 12 g/t Au equivalent in an extension to the JM zone of the **Shasta** mine. Waste rock was drilled and blasted; ore will be trucked to the Baker mill for processing. Elsewhere in the Toodoggone, on the **JD** property, AGC Americas Gold Corporation and Antares Mining and Exploration Corporation completed an eleven-hole drilling program, designed to test the extension of the Creek zone and the newly discovered Orest zone, a parallel zone to it. The companies now interpret these zones to be related to a porphyry system with gold-silver-zinc-lead mineralization occurring within a quartz-carbonate stockwork.

During 1998, Bull River Mineral Corporation completed a major program of underground development at the **Bull River** copper-silver-gold prospect, where quartz-ferrocarbonate with chalcopyrite and pyrrhotite veins in fractures are hosted by Middle Aldridge Group siliciclastic rocks. The veins range from 0.3 to 6 metres in width. The 16% decline has progressed to approximately 2.7 kilometres from the portal; the company reports that drilling from the new underground development into the area of the potential resource has verified its surface drilled mineral zone model. Crosscutting vein systems from the 3, 5, 7 and 9 levels is planned between July and September, 1999.

At the **Taurus** gold project, adjacent to the Table Mountain mine in the Cassiar district, Cusac Gold Mines Ltd. signed an option and joint venture agreement with International Taurus Resources Inc. A key term of the agreement includes the right for Cusac to mine up to 250 000 tonnes per year from the Taurus property, subject to a net smelter return royalty to International Taurus. Ore will be milled at Cusac's Table Mountain facility. Previous work on the Taurus project, by Cyprus Amax Ltd. and International Taurus, developed a drill-indicated resource of 13.9 million tonnes grading 1.01 g/t Au.

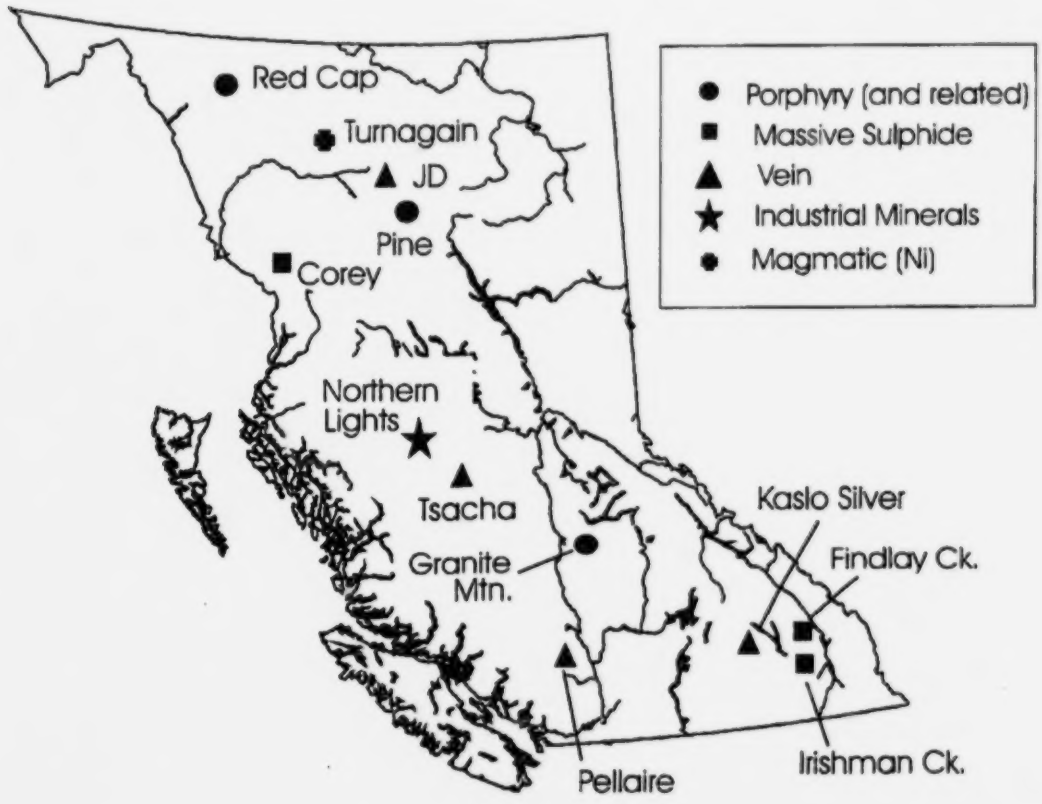

Figure 8. Major exploration projects in British Columbia - 1998.

At the **Tsacha** epithermal gold property, in the southern Interior Plateau region south of Vanderhoof, Teck Corporation and Corona Gold Corporation resumed drilling on a series of north-striking, steeply dipping, auriferous quartz veins. For one of these, the Tommy vein, Teck estimated a resource of 440 000 tonnes grading 8.5 g/t Au, using a 5 g/t cut-off. This resource lies above a diorite sill which cuts the vein at a depth of approxiately 120 metres. Several holes, drilled beneath this sill in 1998, cut the vein at a depth of approximately 120 metres and encountered similar style mineralization, adding potential to increase the resource. Drilling also targeted the Larry vein which parallels the Tommy vein approximately 150 metres to the east, where previous drilling has yielded encouraging results.

At the **Kaslo Silver** silver-lead-zinc property on Keen Creek, east of the historic Slocan silver camp, Cream Minerals Ltd. continued diamond drilling along a 9-kilometre shear zone, testing five areas (Silver Bear, Gold Cure, Bismark, Gibson and Cook South) with previously known mineralization. Over the past 20 years, local prospector Eric Denny has consolidated ownership of the claims which cover both high-grade, vein mineralization, and also massive sulphide replacement mineralization located where limestone units intersect the main shear zone(s) *(e.g.* Cork zone*)*. These shear zones average 25 metres in width. Drilling specifically tested for ore shoots below the mine workings on the Cork zone. The company also began assessing the high-grade dumps

TABLE 2. NEW MINES, CLOSURES, DEVELOPMENT AND AVANCED EXPLORATION PROJECTS - 1998

Company Name	Project	Commodity Name	Estimated Tonnes (000s)	Estimated Grade	Reference
New Mines					
Royal Oak Mines Inc.	Kemess South	Cu, Au	200 400	0.22% Cu, 0.63 g/t Au, 0.008% Mo	Royal Oak, 1996
Claimstaker Res. Ltd./Jipangu Ltd.	Blackdome	Au	238	13.03 g/t Au, 37.03 g/t Ag	Claimstaker, 1998
Development					
Fireside Minerals Ltd.	Fireside	Barite	5200		Fireside, 1997
Closures					
Kinross Gold Corporation	QR	Au			
Advanced Exploration					
Porphyry (and related) Deposits					
Taseko Mines Ltd.	Prosperity (Fish Lake)	Cu, Au	633 000	0.253% Cu, 0.466 g/t Au	Taseko Mines, 1998
American Bullion Minerals Ltd.	Red Chris	Cu, Au	118 900	0.584% Cu, 0.47 g/t Au	American Bullion, 1998
Imperial Metals Corp.	Similco - all zones	Cu, Au	128 794	0.397% Cu, 0.155 g/t Au (est.), 1.576 g/t Ag (est.)	Imperial Metals, 1998
International Skyline Gold Corp.	Bronson Slope	Cu, Au, Ag	79 000	0.48 g/t Au, 0.17% Cu, 2.70 g/t Ag, 0.006% Mo	International Skyline, 1998
Imperial Metals Corp.	Giant Copper (AM & Invermay)	Cu, Au, Ag	45 373	0.47% Cu, 0.38 g/t Au, 11.19 g/t Ag	Imperial Metals, 1998
Booker Gold Expl'n. Ltd./	Morrison	Cu	123 200	0.38% Cu, 0.203 g/t Au	Booker Gold, 1998
Noranda Mining and Expl'n. Inc.	Hearne Hill	Cu	4 230	0.6% Cu, 0.186 g/t Au	
Getty Copper Corp.	Getty North Getty South	Cu Cu	72 093 36 000	0.31% Cu 0.47% Cu	Getty, 1998
Massive Sulphide Deposits					
Redfern Res. Ltd.	Tulsequah Chief	Cu, Pb, Zn, Au, Ag	7910	1.27% Cu, 6.35% Zn, 1.18% Pb, 2.42 g/t Au, 100.9 g/t Ag	Redfern, 1996
Weymin Mining Corp.	J&L	Zn, Pb, Ag, Au	3600 (Main)	3.9% Zn, 3.0% Pb, 81 g/t Ag, 7.24 g/t Au	Weymin, 1997
			1000 Yellow Jacket	7.1% Zn, 2.5% Pb, 52.5 g/t Ag	

Company Name	Project Name	Commodity	Estimated Tonnes (000s)	Estimated Grade	Reference
Vein Deposits					
Bralorne-Pioneer Gold Mines Ltd./ Avino Mines and Res. Ltd.	Bralorne Above 800 level	Au, Ag	432.5	10.6 g/t Au	Bralorne Pioneer, 1996
International Wayside Gold Mines Ltd.	Cariboo Gold Quartz	Au	3080	3.5 g/t Au	International Wayside, 1998
Canarc Res. Corp.	Polaris-Taku	Au	3270	13.7 g/t Au	Canarc, 1997
Misty Mountain Gold Ltd.	Specogna (Cinola)	Au, Ag	33 500	2.11 g/t Au	Misty Mtn., 1998
Bul River Mineral Corp.	Bull River	Cu, Au, Ag	5 300	2.25% Cu, 36.3 g/t Ag, 12 g/t Au	Bul River, 1998
International Taurus Res. Inc./ Cusac Gold Mines Ltd.	Taurus	Au	13 900	1.01 g/t Au	International Taurus, 1996
Skarn/Manto Deposit					
Imperial Metals Corp.	Silvertip (Midway)	Zn, Pb, Ag	2 570	8.8% Zn, 6.4% Pb, 325 g/t Ag 0.63 g/t Au	Imperial, 1998
Industrial Mineral Deposits					
Mountain Minerals Co. Ltd.	Ranchlands	zeolite			Mountain Minerals, 1996
Canmark Int'l Res. Ltd.	Sunday Creek	zeolite			Canmark, 1995
Okanagan Opal Inc.	Klinker	fire opal			Okanagan, 1995
Monteith Bay Res.	Monteith Bay	silica			Monteith Bay, 1998
Whitegold Res. Corp.	Isk	wollastonite	1020	58.14%	Whitegold, 1998
Cassiar Mining Inc.	Cassiar	asbestos, magnesium	17 000	>4% fibre	Cassiar, 1998
Ava Res. Ltd.	Wishaw	quartzite			Ava, 1995
Bul River Mineral Corp.	Aspen	feldspar			Bul River, 1998
IG Machine & Fibres Ltd.	Slesse	limestone			IG Machine, 1998
IG Machine & Fibres Ltd.	Ashcroft	basalt			IG Machine, 1998
Highwood Res. Ltd.	Jubilee Mtn.	Barite			Highwood, 1998
Anglo Swiss Res. Inc.	Blu Starr	sapphire, garnet, graphite			Anglo Swiss, 1998
IMP Ind. Min. Park	Black Crystal	graphite	1500		IMP, 1998
Coal Deposits					
Luscar Ltd.	Telkwa	coal	50 000	thermal	Manaltz, 1997
Pine Valley Coal Ltd.	Willow Creek	coal	15 600	metallurgical	Pine Valley, 1997
Quinsam Coal Corp.	T'Sable River	coal	38 478	thermal	Quinsam, 1996
Pacific West Coal Ltd.	Tulameen	coal	21 000	thermal	Pacific West, 1997
Western Coal Corp.	Belcourt	coal	103 200	metallurgical	Western Coal, 1998

on the property, for possible processing at the newly renovated, nearby Ainsworth mill. Surface exploration identified an additional six drill targets along the strike of the main shear at north end of the property. A late-season, 760-metre drilling program focused on the Bismark and Cork North zones. The latter will be explored for its replacement-style mineralization at depth and along strike.

SKARN/MANTO DEPOSITS

In April 1998, Silvertip Mining Corporation, a subsidiary of Imperial Metals Corporation, filed an Environmental Assessment Process application for the **Silvertip** (formerly Midway) high-grade precious and base metals deposit, near the B.C.-Yukon border. The company estimates a resource of 2 570 000 tonnes grading 325 g/t Ag, 6.4% Pb, 8.8% Zn and 0.63 g/t Au. It considers that there is potential for expansion of this resource and proposes to develop an open-pit and underground mine to feed a 2000 tonne per day dense-media plant and flotation mill, producing high-value lead and zinc concentrates. In 1998 the company focused on permitting issues associated with the process application. It also conducted a geophysical program to investigate favourable geologic environments for manto/chimney mineralization in the dolomitic Tapioca sandstone, which underlies the McDame limestone.

MAGMATIC NICKEL

At the **Turnagain** ultramafic-hosted, disseminated nickel-cobalt showing, 70 kilometres east of Dease Lake, Bren-Mar Resources Ltd. completed a five-hole drilling program in conjunction with a bore-hole EM orientation study. Also, a laboratory testing program consisting of concentrate production, pressure-leaching studies, solvent extraction and electrowinning is in progress. Nickel-bearing sulphides have been intersected on the property up to 490 metres in depth over a strike length of 3.7 kilometres. The target is a bulk-tonnage (in excess of 225 million tonnes) nickel-cobalt deposit that is suitable for large-scale open-pit mining.

COAL DEPOSITS

During 1998, off-lease coal exploration was undertaken at Telkwa, Willow Creek, Belcourt, Tulameen, McGillivray Creek and Middle Mountain.

At the **Telkwa** thermal coal project, Manalta Coal Limited (now Luscar Ltd.) spent approximately $520 000 on in-fill drilling, geotechnical drilling and drilling for acid rock drainage samples. Drilling was in the proposed pit east of Goathorn Creek and in the Tenas Creek area. The in situ resource of the Telkwa property is estimated to be 125 million tonnes. The mineable reserve, contained in six separate pits, is estimated to be 50 million tonnes. Luscar intends to continue with Manalta's plan to apply for Mine Development Certificate. It proposes to produce between 1.0 and 1.5 million tonnes per year over a 23-year mine life, employing 211 persons.

In the Northeast, at the **Willow Creek** project, Pine Valley Coal Limited has plans for a 900 000 tonnes per year operation for 15 years, based on a 15.6 million tonne reserve of metallurgical and thermal coal. The company received a Mine Development Certificate in the spring of 1998. The property is in the process of being converted into a mine lease and construction is planned for 1999. During 1998 there were two bulk-sampling programs at Willow Creek, to provide samples for customers. In one program, 200 kilograms were collected for testing as a PCI coal; in the other program, 600 kilograms were obtained for testing the carbonization characteristics of the coal and its applicability as a semi-soft coking coal. At present, there are no plans for additional exploration prior to a commitment to start production.

At the **Belcourt** property in the northeast, about 100 kilometres south of Quintette, Western Coal Corporation conducted a drilling program on the Holtslander reserve area to confirm structure, coal seam thickness and basic coal-quality data. A more detailed exploration program is planned for 1999. To date, a resource of about 18 million tonnes has been outlined, with the potential for additional resources in the Red Deer area of the property.

At the **McGillivray** Creek property in the Southeast, Fording Coal Limited mined a bulk sample of about 30 000 tonnes, which was shipped to Coal Mountain Collieries for test washing. In addition, a modest exploration drilling program was completed to better delineate the structure and provide more coal-quality data.

Fording Coal Limited also conducted a modest drilling program on its **Middle Mountain** project, north of Coal Mountain Collieries.

Pacific West Coal Limited proposes to mine about 100 000 tonnes per year of high-volatile C to B bituminous coal on the **Tulameen** property. In 1998 it spent approximately $395 000 on drilling, preparation of a site for a 10 000-tonne bulk sample, and on environmental studies. It plans to sell coal to local cement plants and to truck product to Vancouver and Washington State.

INDUSTRIAL MINERALS DEPOSITS

In 1998, industrial minerals exploration expenditures are estimated at approximately $1.5 million, down from the $3.0 million spent in 1997. An $8-million pilot plant, to recover short-fibre **asbestos** from the **Cassiar Asbestos** tailings (17 million tonnes), has been assembled by Cassiar Mining Inc., a wholly owned subsidiary of Minroc Mines Inc. The plant produced at a rate of 1000 tonnes of fibre per month between August and October 1998. It uses a wet-milling technology. The company plans to expand the plant to a capacity of 50 000 tonnes of fibre per year. The capital cost of this phase is estimated at approximately $23 million. The tailings reclaimation operation is expected to continue at this rate for 13 years. A Japanese trading company, Kakiuchi Co. Ltd., will help finance the capital costs and will market the product. Cassiar is also examining the potential to recover magnesium metal, by leaching cleaned serpentine which is estimated to make up approximately 20% of the tailings pile. The company also receives a modest cash

flow from the sale of approximately 50 to 100 tonnes of nephrite jade annually. It plans to employ up to 60 people at the site in 1999.

In early 1998, Whitegold Resources Corporation completed a feasibility study on its Bril deposit, part of the **Isk wollastonite** project. A reserve is estimated by Rescan Engineering Ltd. at 1.02 million tonnes of 58.14% wollastonite (using a 50% grade cut-off) which would support a 20-year mine life. A geological resource is estimated by the company at 20 million tonnes; the property contains five other surface deposits. The company has not yet applied to enter the Environmental Assessment Process.

IMP Industrial Park Mining Corporation continued market studies for **graphite** from its **Black Crystal** property, near Slocan. In 1998, the company completed a mapping program over its low-grade, crystalline graphite prospect. The favourable zone is over 1800 metres long and 85 metres wide. Two promising zones were identified: a 360-kilogram bulk sample was taken from the No. 1 zone for metallurgical testing and grade determination.

Anglo Swiss Resources Inc. continued sampling and evaluating the economic potential of the **Blu Starr/Blu Moon sapphire** properties and other prospects in the Slocan Valley. The gemstones occur in core gneisses of the Valhalla complex within the Omineca Crystalline Belt. Gem-quality **aquamarine** has been found in pegmatitic dikes in the Valhalla Gneiss Complex near **Airey Creek**, west of the Slocan Valley. During 1998, Anglo Swiss announced the discovery of gem-quality garnets, an additional sapphire occurrence, an iolite gemstone (water sapphire) occurrence, and a large mineralized area containing crystalline graphite and new zones of aquamarine beryl. The company shipped approximately 1000 carats of rough, gem-quality garnet to three separate cutting facilities in Sri Lanka to evaluate the quality of the facetting. Total extraction over the summer exceeded 250 000 carats of rough garnet from about 2 tonnes of pegmatite. The new sapphire showing, **Sapphire Hill**, has a surface area approximately twice the size of the Blu Starr showing. Sapphire crystals were cleaned and prepared for shipment to Sri Lanka for heat treatment to optimize their colour and clarity. Anglo Swiss also sorted and stockpiled facet-grade iolite material. The company was granted placer claims along the Slocan and Little Slocan rivers, and plans to test the potential for placer gemstones. Okanagan Opal Inc. continued marketing precious opal from the **Klinker** property near Vernon.

Mining companies, as well as individual prospectors, are evaluating new **dimension stone** properties. Northwest Landscape Supply Ltd. is considering applying for a lease on its Spumoni claim on Brohm Ridge, following successful marketing of basalt facing-stone in Whistler. Near Golden, a zone of bedded, dark pink **quartzite**, 50 metres thick, and suitable for ashlar and other split-stone products, is being evaluated. Ava Resources Ltd. continued testing its attractive pink, banded **Wishaw** (Kawa) **quartzite** deposit, east of Prince George. It may attempt to market split-stone and tiling products in the Lower Mainland.

A small shipment of blocks for processing from the **Aspen** claims near Mackenzie was made to test the market. Near Galloway in the Southeast, Bul River Mineral Corporation continued to test the market for the **syenite** building-stone product from its **Aspen** property. It drilled a number of holes and block modeling continues.

In Chilliwack Valley, I.G. Machine and Fibres Ltd. extracted a 35 000-tonne bulk sample of **limestone**, and conducted a diamond drilling program to confirm and expand the resource of its **Slesse** project. The limestone will be shipped to company's plant in Sumas, Washington to be used in manufacturing asphalt shingles. At full production the plant is expected to produce approximately 240 000 tonnes annually.

On **Texada Island**, Consolidated Van Anda Gold Ltd. completed construction of a processing mill and hasapproval to process a 10 000-tonne bulk sample of **magnetite** from the Paxton pit area. The mill will initially produce magnetite as a heavy medium for use in the coal industry. Magnetite has also been successfully tested as a sandblasting abrasive and would be a substitute for silica sand. A small amount of material was milled in 1998.

Continental Lime Ltd. is examining the process to advance its proposed 250 000-tonne per year chemical **limestone Var** quarry, on Rupert Inlet near Port Hardy, into the Environmental Assessment Process. During 1998, the company built roads and drill pads in preparation for a 6000-metre drilling program scheduled to start in early 1999. It is also proceeding with baseline environmental work, First Nations consultation and feasibility studies.

At the **Monteith Bay silica** site on western Vancouver Island, Tilbury Cement Ltd. completed a limited work program in preparation for mining in 1999.

With a contract to supply roofing granules to IKO Industries Ltd. plants in Sumas, Washington and Calgary, Alberta, I.G. Machine and Fibres Ltd. (a subsidiary of IKO) has applied for a permit to mine 24 900 tonnes per year of **volcanic rock** from its **Ashcroft** quarry. As a result of a government decision late in 1998 to raise the Environmental Assessment Process threshold level to 250 000 tonnes per year, the company is expected to raise the production in its application. The quarry and crushing/screening plant would require 60 to 70 full-time jobs and a capital investment of $20 million. A small bulk sample was taken in 1998.

Several barite showings between Jubilee Mountain and Brisco were trenched and drilled in 1998.

TABLE 3. 1998 EXPLORATION HIGHLIGHTS

Company Name	Project Name	Commodity	Estimated Tonnes (000s)	Estimated Grade	Reference
Massive Sulphide Deposits					
Kennecott Can. Explr. Inc /Miner River Res. Ltd./ Eagle Plain Res. Ltd.	Findlay Ck./ Greenland Ck.	Zn, Pb, Ag			Miner River, 1998
Kenrich Mining Corp./ Prime Res. Gp. Inc.	Corey	Au, Ag, Zn, Pb			Kenrich, 1998
Kennecott Can. Explr. Inc/ Sedex Mining Corp.	Irishman Ck.	Zn, Pb, Ag			Sedex, 1997
Porphyry (and related) Deposits					
Stealth Mining Corp.	Pine	Cu, Au	70 000	0.15% Cu, 0.57 g/t Au	Stealth, 1998
United Gunn Res. Ltd./ Oakmont Ventures Ltd.	Granite Mtn.	Cu, Mo			United Gunn, 1998
Xplorer Gold Ltd.	Red Cap	Cu, Mo, Au, Co			Xplorer, 1998
Vein Deposits					
Cream Minerals Ltd.	Kaslo Silver	Ag, Zn, Pb			Cream, 1998
Teck Corp./ Corona Gold Corp.	Tsacha	Au, Ag	440	8.5 g/t Au	Teck, 1996
AGC Americas Gold Corp./ Antares Mining and Explr. Corp.	JD	Au			
Sable Res.	Baker	Au			
International Jaguar Equities Inc.	Pellaire (Lord River)	Au			International Jaguar, 1998
Magmatic Deposits (Ni)					
Bren-Mar Res. Ltd.	Turnagain	Ni, Co, Cu			Bren-Mar, 1998
Industrial Minerals					
Bruce Holden	Northern Lights	Opal			---

GOVERNMENT INITIATIVES

The Government of British Columbia introduced a number of new measures in 1998, to assist mineral resource planning, exploration, and development and continued the successful Prospectors Assistance Programand field programs of the Geological Survey Branch. Highlights are as follows:

- Introduction of the ***Mining Rights Amendment Act***, recognizing the right to mine, and assuring access to mineral tenures, providing for the right to compensation when tenures are expropriated for parks, and ensuring timely permitting of projects.
- Introduction of the ***Mineral Exploration Code***, creating a one-agency approach for permit approvals, and applying environmental protection standards designed specifically for exploration.
- Introduction of the British Columbia **Mining Exploration Tax Credit Program** (METC), a refundable program worth approximately $7 million in 1998/99, rising to $9 million in 1999/2000 and future years. Effective August 1, 1998 expenditures made by eligible individuals and corporations conducting grassroots mineral exploration in British Columbia may qualify for a 20% refundable credit.
- The province streamlined the criteria for determining which projects require a full environmental assessment review under the *Environmental Assessment Act*. The changes resulted in the following new, reviewability thresholds. In addition, the

definition of 'mineral mine' was amended to remove industrial minerals and transferred them to the construction stone and industrial mineral quarries category.

Mining Projects	Previous Threshold	New Threshold
Coal Mines	100 000 t/yr	250 000 t/yr
Mineral Mines	25 000 t/yr	75 000 t/yr

- To encourage new mine development in the province, the **New Mine Allowance Initiative** which provides for a one-third gross-up of the capital costs of new mines was extended for 10 years to new mines that begin production before January 1, 2010.
- The **Prospectors Assistance Grant Program** (PAA) is designed to promote grassroots prospecting for new mineral deposits in British Columbia. It contributed up to 75% of eligible costs of an approved project to a maximum of $10 000. Fifty-two grants were awarded in 1998. Several new discoveries were reported by recipients. Approximately $40 000 were also issued to seven industry organizations to help them deliver training programs to prospectors. The Ministry also provided basic prospectors training. The budget of the PAA program was $500 000.
- The **Geological Survey Branch** programs focused on regions where significant mineral potential is indicated: Devono-Mississippian massive sulphide deposits in northern British Columbia, Robb Lake, Toodoggone (Kemess), Babine, Sitlika, Kootenay Terrane (Eagle Bay) and Gibraltar. A project investigating the existence of and potential for Carlin-type deposits *(e.g.* at Golden Bear*)* continued. Several smaller scale projects were carried out on coal and industrial minerals. Results of these programs are expected to encourage base and precious metals exploration.
- The **Nechako Plateau - Babine Porphyry Belt NATMAP Program** by the Geological Survey Branch and the Geological Survey of Canada in the Nechako River (93F), Fort Fraser (93K) and parts of the Smithers (93L) and Prince George (93G) map areas completed its fifth and final field-mapping year. A proposal for a new bedrock mapping NATMAP **"The Ancient Pacific Margin Project"**, co-sponsored by the Geological Survey of Canada, the Geological Survey Branch, the Yukon Geology Program, and the United States Geological Survey, was made in 1998. The proposal will focus on the epicratonic terrains (Kootenay and Yukon-Tanana) of the Cordillera.
- The release of **Regional Geochemical Survey** (RGS) data for the Mesilinka (94C) map area, as well as archived data for the Hazelton (93M) and Manson Creek (93C) map areas, in July 1998, resulted in claims being staked.
- The **ARIS** (assessment reports), **MINFILE** and **Map Place** databases were upgraded and made easily accessible to clients, on the Ministry's website (http://www.em.gov.bc/geology).
- The Ministry reorganized the **Vancouver Mineral Development Office** to better assist clients with exploration, development, land-use planning and permitting procedures.

OUTLOOK FOR 1999

The fallout of the Asian economic crisis on the global mineral industry is expected to continue to have a negative effect on exploration and development in British Columbia in 1999.

The search for sedex deposits in the southeast part of the province is expected to intensify, following up on work at the **Findlay Creek**, **Greenland Creek** and **Irishman Creek** projects.

Interest in the potential for discovery of deposits similar to the **Pogo** and **Fort Knox** orebodies, currently being exploited in Alaska, is expected to intensify in British Columbia, especially in the Kootenay Terrane and Shushwap Metamorphic Complex.

Positive exploration results at the **Eskay Creek** mine will continue to attract attention to the potential for strataform, gold-enriched (seafloor hydrothermal) deposits. Volcanogenic polymetallic sulphide deposits *(e.g.* **Myra Falls** and **Tulsequah Chief***)* offer small to medium tonnage and high-grade potential, particularly those enriched in precious metals. Despite a planned closure between mid-December and April 1, 1999 Boliden plans an aggressive exploration and development program at its Myra Falls mine in 1999.

There is good potential for the discovery of lead-zinc skarn (cf. Broken Hill, Australia) mineralization, particularly in the area northwest of Revelstoke.

Exploration for Carlin-type gold mineralization is expected to increase in the Tatsamenie Lake area *(e.g.* **Golden Bear***)* and in the Queen Charlotte Islands *(e.g.* **Specogna***)*.

The infrastructure and mineral resources and potential of the **Premier** mine continue to be examined by interested parties with potential mines along the Coast. Development decisions for the **Telkwa** and **Willow Creek** coal projects are expected in 1999.

ACKNOWLEDGMENTS

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The Ministry appreciates the contribution of data by the exploration and mining community in British Columbia.

NORTHWEST REGION

By Paul Wojdak, P. Geo.
Regional Geologist, Smithers

SUMMARY

The year 1998 was a difficult period for the mining industry. Endako molybdenum mine reduced production and cut costs due to the plummeting molybdenum price, in order to remain in operation. Huckleberry copper mine, faced with payback of capital costs and a low copper price, maximized concentrate production by increasing mill throughput. Eskay Creek, with its phenomenal gold and silver grades continues to be highly profitable. The new 150 tonne per day mill completed its first year in operation. Aggressive exploration drilling in the vicinity of Eskay Creek was the largest exploration project in northwest British Columbia. Snip mine, a consistently low-cost producer, poured its millionth ounce of gold on November 2. However, exploration was unsuccessful and the mine will close May 31, 1999.

Four mines operated during the summer months on a bulk sample, pilot plant to full production basis. Golden Bear enjoyed its second profitable season of heap-leach mining, recovering more gold at lower cost than expected. Open-pit mining and heap-leach recovery will continue next year from the Ursa deposit. Table Mountain mine operated for a short period, mining the extension of auriferous quartz veins east of the Erickson fault. At Cassiar, a pilot plant processed chrysotile-asbestos tailings from the former mining operation, and expansion to full production is planned. Barite was produced from the Fireside quarry, east of Watson Lake, for the Alaskan and northeast British Columbia oil and gas drilling industry.

Exploration spending in the Northwest declined to the lowest level recorded in recent times; $8.75 million from $28 million in 1997 and $49 million the preceding year. Claim data show a marked decline in the amount of claimed land, three times as many mineral claim units lapsed as were staked. Exploration drilling fell to 43 000 metres from 102 000 metres and 213 000 metres in the two prior years. A single company, Homestake Canada Inc. with its programs in the Eskay Creek area, accounted for 45% of the expenditure and 55% of the drill footage recorded in 1998. A major reason for reduced spending and drilling is that there was comparatively little work on advanced projects. The Red Chris, Bronson Slope and Isk Wollastonite projects were all inactive. Redfern Resources Ltd. received a Mine Development Certificate for the Tulsequah Chief polymetallic massive sulphide deposit but development progress was slow. The focus of activity at Silvertip (formerly Midway) was on entering the environmental assessment process and there was no exploration for silver-lead-zinc mantos. Work on the Harmony prospect on the Queen Charlotte Islands focused on metallurgical testing of biological oxidation followed by heap-leach gold recovery. Pre-development exploration was essentially completed on the Telkwa thermal coal project but acquisition of Manalta Coal Ltd. by Luscar Coal Ltd. slowed progress of the project through the environmental assessment process.

Self and company-employed prospectors were active and successful in finding new showings in northwest British Columbia such as the Chisholm Lake and Shea porphyry copper, Sail volcanogenic and Thorn enargite showings. Promising early-stage projects being advanced by (mainly) junior companies include:

- Consolidated Magna Ventures enhanced potential of the Big Onion porphyry copper prospect near Smithers by discovering the faulted southwest continuation of the mineralized zone.
- Teck Corp. detected anomalous gold values from surface sampling of two "old" porphyry targets, the Jake and Kit properties north and northwest of Smithers.
- Telkwa Gold Corp. clarified the volcanogenic character of the Del Santo massive sulphide prospect near Smithers and detected EM and magnetic anomalies along strike.
- Homestake Canada Inc. conducted grassroots exploration throughout the Iskut district, including work on the PRU block of the Corey claims optioned from Kenrich Mining Corp.
- Rimfire Minerals Corp. confirmed the similarity in geological setting of the RDN property and the Eskay Creek deposit, but trenching of a geochemical anomaly failed to reach bedrock.
- Boliden Westmin Limited found new zinc-copper showings northeast of Dease Lake (Sail claims) in Devono-Mississippian metavolcanic rocks, probably correlative with the Yukon-Tanana Terrane.
- Eveready Resources Corp. is encouraged by its trenching and drilling evaluation of zinc-lead-silver replacement deposits in carbonate rocks near Cassiar.
- Xplorer Gold Corp. drilled Red Cap, a telescoped porphyry prospect near the Taku River, in search of gold and cobalt in a large calcsilicate alteration zone.

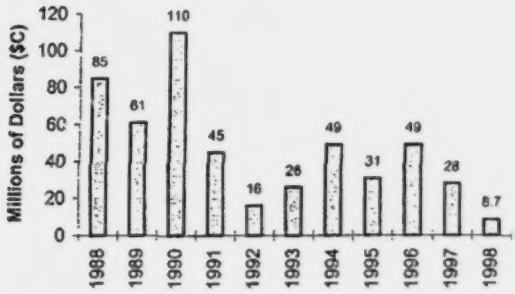

Figure 1. Mineral exploration expenditures in Northwest British Columbia.

EXPLORATION TRENDS

The sharp decline in exploration activity since 1996, to $8.75 million in expenditure and 42 939 metres of drilling, is shown in Figures 1 and 2. Few junior exploration companies were able to raise project funding and most major mining companies were absent from the Northwest. The number of new mineral claim units declined to 4460 and the number of forfeited mineral claim units rose to 14 426, resulting in a large net decrease of 9966 units in good standing (Figure 3). There was a post-1992 peak in exploration spending and drilling in 1996, which is also the only year when there was a net gain in mineral tenure in the Northwest. Province-wide statistics also show a steady decline in mineral claim units since 1990.

Mines, advanced exploration and early stage projects are shown on Figure 5. Table 1 lists properties which were explored by drilling and projects with expenditures over $100 000. Of the properties listed in Table 1, all but two (RDN and Corey - PRU block) have a long exploration history, continuing a recent trend of exploration work on known prospects. However, on many known prospects work focused on targets that had not been drilled previously (e.g. Big Onion, Louise Lake, Endako). New showings were found on the, Shea (Figure 4) and Sail claims, the latter in an area with no previously recorded mineralization.

Mine-site exploration was conducted at all major operating properties; Endako, Huckleberry, Snip, Eskay Creek and Golden Bear. On exploration properties, gold continues to be the most sought after commodity, primarily in epithermal massive sulphide (Eskay Creek type) deposits and gold-enriched porphyry copper deposits. High-grade, polymetallic massive sulphide deposits in volcanic or carbonate rocks are also popular. Molybdenum, nickel, cobalt, industrial minerals and coal are targeted by individual or specialized companies.

Several companies reclaimed old camps and other environmental disturbance on exploration sites, in order to diminish their liability and to have security bonds returned. Silver Standard Resources Inc. was active at five sites including the historic Silver Standard mine near Hazelton. Large abandoned camps were cleaned up at Yellow Giant (by Doublestar Resources Ltd.), Sib (by Heritage American Resource Corp.), Erickson-Ashby (by Xplorer Gold Corp.) and Kerr (by Placer Dome Inc.).

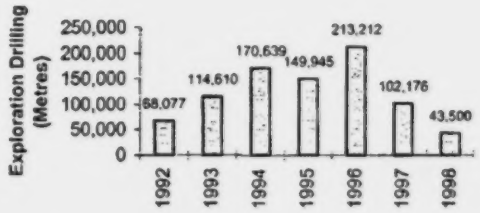

Figure 2. Exploration drilling in Northwest British Columbia.

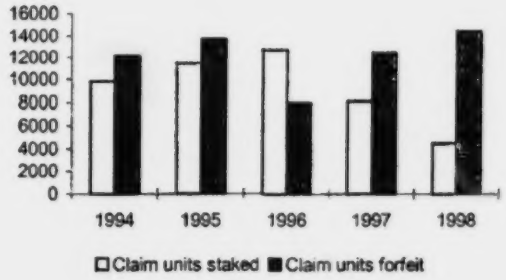

Figure 3. Claim summary, Northwest British Columbia.

Figure 4. Shea claims; prospecting new logging road continues to be a rewarding strategy, (left to right) Bob Hamblin, Daryl Hanson and Bruce Hobson.

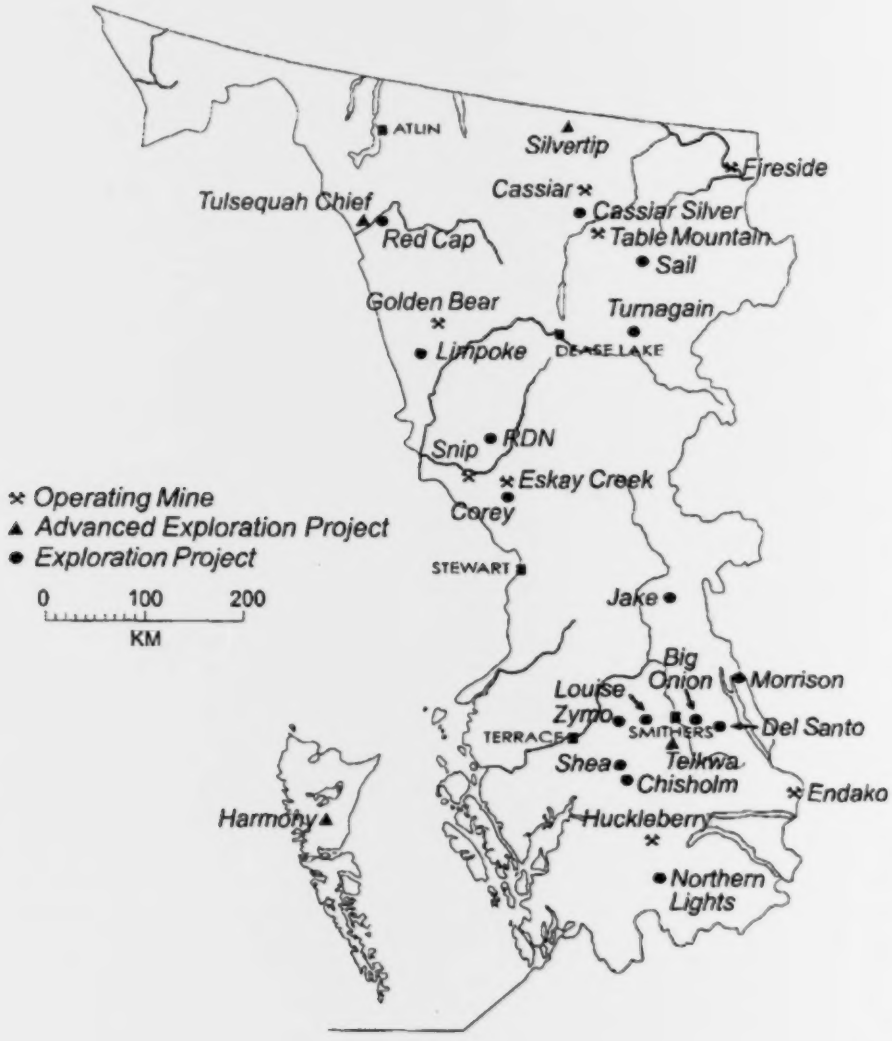

Figure 5. Location map, mines and exploration projects in northwest British Columbia, 1998.

METAL MINES

Endako, generally regarded as a low cost molybdenum mine, is owned and operated by a joint venture of Thompson Creek Mining, Ltd. and Nissho Iwai Moly Resources Inc. Early in 1998 the company bought an in-pit crusher from the recently closed Island Copper mine and began its reassembly at Endako. When in service, it will significantly reduce production costs. However, five months later the price of molybdic oxide fell 50% to $US2.10 per pound. The company deferred installation of the crusher, reduced mine production by one-third and reduced production costs by supplementing mill feed from the low-grade stockpile. An agreement between management, labour and suppliers of goods and services, brokered by the provincial Job Protection Commission, further reduced costs and staved off a planned shut down of the mine. Reserves on January 1, 1998 were 121 757 000 tonnes grading 0.065% Mo. Ore mined in the year was about 9 million tonnes grading 0.074% Mo, all from the Endako pit. Mill recovery averaged 77% and production was 5 558 000 kilograms (12.25 million pounds) of molybdenum.

The deposit is a quartz-molybdenite vein stockwork within the Late Jurassic to Early Cretaceous Francois Lake batholith, a multiphase intrusion of granite, quartz

TABLE 1. MAJOR EXPLORATION AND DRILLING PROJECTS IN NORTHWEST REGION, B.C.

PROPERTY	OPERATOR	MINFILE	NTS	COMMODITY	TYPE	WORK DONE
Big Onion	Consolidated Magna Ventures Ltd.	93L 124	93L/15	Cu, Mo	Porphyry	IP, 40 kilometres; 6 ddh, 1000 m.
Cassiar Silver	Eveready Resources Corp.	104P 006,044, 080	104P/5	Zn, Pb, Ag	Replacement vein, chimney/manto	Geol; 9 trenches, 270 m.; 8 ddh, 1525 m.
Corey - PRU block	Homestake Canada Inc.	104B 011	104B/7,8	Au, Ag	Epithermal massive sulphide	Grid, 46 kilometres; geol; geochem; 4 ddh, 1262 m.
Cub (Turnagain)	Bren-Mar Resources Ltd.	104I 014, 119, 120	104I/7	Ni	Magmatic	5 ddh, 1448 m.; down-hole pulse EM
Del Santo	Telkwa Gold Corporation	93L 025	93L/10	Cu, Zn, Ag	Volcanogenic massive sulphide	Geol; mag, 21 kilometres; 6 trenches, 203 m.; 4 ddh, 375 m.
Endako	Thompson Creek Mining Ltd.	93K 006	93K/3	Mo	Porphyry	Drill access, 1 kilometres; 7 ddh, 875 m.
Eskay Creek	Homestake Canada Inc.	104B 008	104B/8	Au, Ag	Epithermal massive sulphide	Geol; 90 ddh, 21 904 m.
Golden Bear	North American Metals Corp.	104K 087	104K/1	Au	Carlin-type	53 rdh, 1325 m; 2 ddh, 908 m.
Harmony	Misty Mountain Gold Limited	103F 034	103F/9	Au	Epithermal	4 ddh, 575 m.; met sample, 4 tonnes
Huckleberry	Huckleberry Mines Ltd.	93E 037	93E/11	Cu, Mo	Porphyry	7 ddh, 994 m.
Keystone	Nu-Lite Industries Ltd.	104J 012	104J/16	Au	Mesothermal vein	Road repair, 9 kilometres; 4 ddh, 690 m.
Louise Lake	Global Mineral & Chemical Ltd.	93L 079	93L/13	Cu, Ag, Au	Porphyry, enargite gold	3 ddh, 460 m.
Morrison	Booker Gold Explorations Ltd.	93M 007	93M/1	Cu, Au	Porphyry	3 ddh, 730 m.
RDN	Rimfire Minerals Corp.	104G	104G/2, 104B/15	Au, Ag	Epithermal massive sulphide	Geol; geochem; linecut, 3.6 kilometres; 3 excavator trenches
Red Cap	Xplorer Gold Corporation	104K 010, 053, 085	104K/11, 14	Co, Au, Ag, Cu	Porphyry, skarn	Max-Min EM and mag; 11 ddh, 1750 m.
Snip	Homestake Canada Inc.	104B 250	104B/ 10,11	Au	Shear vein	1 ddh, 867 m.
Tangle	D. Groot Logging Co. Ltd.	93L	93L/15	Ag, Cu		IP & VLF-EM, 10 kilometres; 4 ddh, 465 m.
Telkwa	Luscar Ltd.	93L 156	93L/11	Thermal Coal	Coal	33 trenches; 37 rdh and 8 ddh, 4792 m.

monzonite and alaskite. Mineralization is controlled by east-west, northeast and northwest-trending fractures and is separated into three main zones (Endako, Denak East and Denak West) by northeast-striking, normal oblique faults. Exploration focused on identifying new resources to the northwest and southeast along trend, the Sam and Bell areas respectively, and expanding the known resource peripheral to the Endako pit. Drilling results for the Sam and Bell areas were disappointing, but drilling on the south and southeast margins of the Endako deposit increased resources.

In October, **Huckleberry** Mines Ltd. completed the first year of operation of its porphyry copper mine 122 kilometres southwest of Houston. In April, Princeton Mining Corporation, 60% owner of Huckleberry Mines Ltd., was merged into Imperial Metals Corporation. Ore milled amounted to 6 547 500 tonnes, averaging 0.632% Cu, from which 36 800 000 kilograms of copper and 248 000 kilograms of molybdenum were produced. Mineable reserves on January 1, 1999 were 80.7 million tonnes grading 0.501% Cu, 0.061 g/t Au, 2.7 g/t Ag and 0.014% Mo based on a copper price of $US1 per pound and a cut off grade of 0.30% Cu (S. Blower, pers. comm.). There were start-up problems in the mill resulting in low production during its first three months of operation, but major modifications to the mill circuit in early 1998 led to an increase in throughput to an average of 20 500 tonnes per operating day, well above design capacity of 16 500 tpd. Mill recoveries were 88.7% for copper and 20.8% for molybdenum in the first three quarters, but improved by year-end to 92% for copper and 50% for molybdenum (P. Campbell, pers. comm.). Ore mined to date is from the East zone starter pit which will be completed in 2000. The Main zone pit, 600 metres west of the East pit, has

been stripped of overburden and its production will be blended with East pit ore in 1999.

In the East pit, ore is derived 85% from Hazelton Group andesite and 15% from a dike, 40 metres wide, emplaced along an ore-controlling 110° fault. The dike is an offshoot of an 82 Ma biotite granodiorite stock which metamorphosed Hazelton Group andesite to biotite hornfels. Best copper grade occurs in the granodiorite dike and in hornfels on the south (footwall) side of the controlling fault (S. Blower, pers. comm.). High mill throughput is possible because strong fracturing south of the fault, and dissolution of gypsum-cemented fractures by ground water, results in unusually soft ore that requires minimal crushing or grinding. This is blended with somewhat harder ore from north of the fault. When mining extends below the water table into more competent rock, mill throughput is expected to be lower (S. Blower, pers. comm.). Huckleberry drilled seven exploration holes in a 700-metre semicircular arc around the west side of the Main stock. A hole near the south contact of the stock intersected a zone of secondary copper enrichment including chalcocite and native copper that grades 0.8% Cu over the initial 27 metres of the hole, and then continued in primary mineralization that averages 0.4% Cu. Mill recovery is poor from oxide and native ore and this area is not currently under consideration for mining. Evaluation of this zone is continuing, to determine if it may be incorporated into the Main zone pit.

The **Eskay Creek** mine increased the tonnage mined and gold-silver production as the 150 tonne per day mill came into full operation, offsetting a decrease in sale of direct-shipping ore. On December 3, 1998 Prime Resources Group Inc., owner of the Eskay Creek mine, became a wholly owned subsidiary of Homestake Mining Company. Ore mined amounted to 91 660 tonnes of shipping ore grading 76.8 g/t Au and 3108 g/t Ag, and 55 690 tonnes of milling ore grading 42.6 g/t Au and 1249 g/t Ag. Yearly production was 8774 kilograms (282 088 oz) of gold and 364 638 kilograms (11 723 400 oz) of silver at a cost of $US132 per ounce of gold equivalent. Mill recovery is 92% for gold and 94.8% for silver. Shipping ore is mined from the 21B zone, a west-dipping sheet of clastic sulphide and sulphosalt beds within mudstone and containing high levels of deleterious elements, mercury, antimony and arsenic. Milling ore comes from the NEX zone, a northern extension of the 21B zone in the hinge of the Eskay anticline that carries acceptable levels of deleterious elements, and from the 109 zone, a pipe-shaped body below 21B, consisting of coarse-grained vein quartz, sphalerite and galena. Reserves on January 1, 1999 were 1 400 000 tonnes grading 57.7 g/t Au and 2493 g/t Ag.

Homestake and Prime Resources continued to acquire land in the Iskut district and carried out exploration both on the Eskay Creek property and regionally. Drilling on the mine and immediately adjacent properties was conducted with four machines. All holes were drilled through the footwall rhyolite to test for mineralized mudstone horizons below the contact mudstone and included the following targets (I. Dunlop, pers. comm.):

- 21C, a rod-shaped pyritic zone within footwall rhyolite (Figure 5). It reaches the surface at the original 21 zone trenches excavated in the 1930s (near the 21A deposit) and plunges gently northward for 900 metres, passing below and 200 metres downdip of the 21B deposit to its truncation by the Argillite Creek fault. Based on 1998 drilling the 21C zone is estimated to contain 303 000 tonnes of milling ore at a grade of 16.4 g/t Au and 72 g/t Ag, with very low levels of deleterious elements.
- The Eskay depositional trough in the contact mudstone was traced southwards beneath Bowser Group cover rocks with holes up to 1350 metres long.
- The contact mudstone was drilled at 100 to 200-metre spacing over a 1-kilometre strike length on the west limb of the Eskay anticline from the 22 zone to the 28 zone.
- The east limb of the Eskay anticline.
- The fringes of the 21A deposit. Encouraging gold intersections were obtained, but arsenic, antimony and mercury are extremely enriched.
- An undrilled gap between the 21A and 21B deposits. A mineralized link between the two deposits was not found; this is somewhat surprising because the south end of 21B resembles the 21A zone, containing realgar and orpiment.

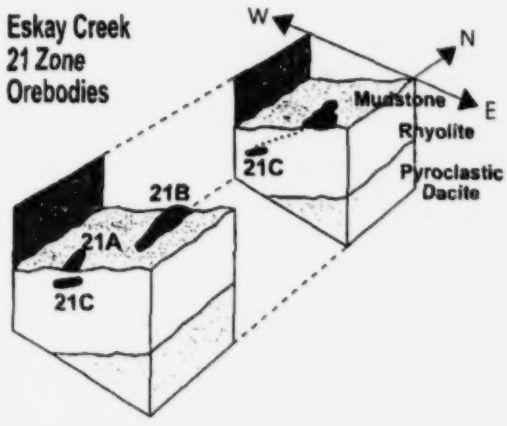

Figure 6. Expanded block diagram of Eskay Creek mineral zones with folding removed.

The Snip gold mine appears to be near the end of its life. The mine is owned by Homestake Canada Inc. Mine production was 3171 kilograms (101 950 oz) of gold from milling of 145 311 tonnes. Recovery in the gravity mill was 91.8% from ore averaging 23.8 g/t Au. Costs were $US204.50 per ounce. The orebody at Snip comprises a principal and several footwall quartz-carbonate-sulphide veins within biotitic shear zones northwest of the dike-shaped, early Jurassic Red Bluff granodiorite. The granodiorite stock contains the Bronson Slope porphyry gold-copper deposit owned by International Skyline Corporation. The Twin deposit at Snip is zoned laterally from massive pyrite-pyrrhotite ore close to the stock, to low pyrite "pink and green" ore (with characteristic molybdenite) further northwest. Pink and green colours are derived from hydrothermal biotite and chlorite. Drilling of the plunge projection 500 metres below the Twin zone was completed without success and exploration was terminated. In December, International Skyline reached agreement with Homestake to extend a Snip mine drift at the 400-metre elevation onto Skyline's claims to conduct exploratory diamond drilling (see Iskut District, Bronson Slope deposit). If exploration is unsuccessful the Snip mine is expected to close May 31, 1999. Recovery of the approximately 2500 kilograms (80,000 oz) of gold remaining in the Snip tailings pond may eventually be considered by successors to the mine site.

At **Golden Bear**, mining and heap-leach gold recovery were reactivated on May 28 by North American Metals Corp. (87% owned and operated by Wheaton River Minerals Ltd.). This seasonal operation shut down on October 21. A total of 397 000 tonnes of ore grading 3.73 g/t Au and 360 000 tonnes of waste were extracted from the Kodiak A pit, which is now mined out. In its second season of operation, the Fleece Bowl pad was filled to capacity (623 000 t) and 200 000 tonnes of Kodiak A ore were stockpiled near Totem Creek. Gold production in 1998 was 1120 kilograms (36 000 oz) with cost declining to $US149 per ounce from $US226 in 1997. The grade of Kodiak A ore was 9% higher than anticipated and gold recovery was better, currently 89%, with an additional 3 to 4% expected next year. The Totem Creek heap-leach pad, with a capacity of 1.1 million tonnes, was readied for operation in 1999 and the gold recovery plant delivered to the site. Ore from the Ursa deposit (open pit reserves of 519,000 t containing 7.0 g/t Au) and the Kodiak A stockpile will be placed on the pad. Pre-stripping was carried out in the Ursa pit.

Gold deposits at Golden Bear are controlled by the Ophir break, a major structure which juxtaposes Paleozoic limestone against Triassic mafic volcanic rocks. The Ursa and Kodiak A oxide deposits are above the 1500-metre elevation and refractory deposits, Bear and Grizzly are at lower elevation. Gold in the Bear deposit, now mined out, was recovered by roasting. In 1998 two exploration holes were drilled north of previous intersections in the Grizzly zone, estimated to contain 152 900 tonnes grading 20.5 g/t Au. The Grizzly zone lies 300 metres below surface and the program was aided by a down-hole directional drilling tool. The pilot hole was within 2 metres of its target position and intersected a broad zone of silicifed fault breccia with subeconomic gold grade (A. Hamilton, pers. comm.). A second hole was wedged to the north with similar results, so that the program did not significantly add to the gold resource. Three fault targets were explored by shallow percussion holes (25 m deep):

- The up-ice termination of mineralized glacial boulders, 200 metres west of the Ursa deposit, where trenching did not penetrate frozen overburden.
- A postulated fault which extends south from the Ursa zone to the Ridge zone (see Mine and Exploration Review 1997 and 1996).
- The South zone, where the Ridge fault intersects an unnamed structure that is weakly anomalous in gold.

Cusac Gold Mines Ltd. operated the **Table Mountain** mine by for about six weeks in September and October and again in December. The Bear vein was mined by an open cut 42 metres long. It grades about 30 g/t Au but with dilution incurred by surface mining the mill head grade averaged about 15 g/t. Gold production amounted to 28.5 kilograms (917 oz) from 1800 tonnes milled. More significantly, this was the first gold production from the extension of the principal veins east of the Erickson fault. West of the fault, these veins have produced 7000 kilograms (225 000 oz) of gold. At time of writing, the company plans to continue underground mining and stockpile the ore for milling in March, 1999. Cusac estimates mine tailings from the 1979-1988 period, contained in a separate pond from post-1994 tailings, total 700 000 tonnes at a grade of 1.25 g/t Au which is 70% recoverable. Cusac acquired the adjoining **Taurus** property and proposes to evaluate mining selected portions of the low-grade gold resource identified by International Taurus Resources Inc.

ATLIN PLACER DISTRICT

by Daryl Hanson, P. Eng. (Geol) , Inspector of Mines

Placer gold exploration and mining in the Atlin Mining Division continued at a steady pace in 1998, producing an estimated 320 kilograms (10 000 oz) of gold and employing about 50 people. Production decreased approximately 10% from the previous year, reflecting a decline in the gold price. Several operations employed innovative mining and recovery techniques to improve their overall economics.

There was mining activity on all the historic creeks in the camp, but most of the work was on Wright, Ruby, Boulder, Spruce, McKee, and Wilson creeks. On **Wright Creek**, Sisters Resources Limited discovered a new shallow channel that it mined by a conventional excavator and truck operation. In places the channel is cut by the deeper main channel that was worked from 1994-97 by the same company. On **Ruby Creek**, Ruby Gold Ltd. continued with a successful program of drilling and blasting 12 metres of Quaternary basalt that overlies the pay-channel gravel on the east side of the creek valley. On **Wilson Creek**, Gary Crawford and Peter Burjoski discovered and mined shallow, orange (Tertiary?) gravel on the west side of the present valley. They also continued a program of drill testing the deep, undeveloped channel to depths of 30 metres or more. Southpaw Ventures Ltd. and Fat Chance Placer Inc. conducted large stripping programs on upper **Boulder Creek** and at the top of the alluvial fan, respectively, in search of the continuation of known high-grade pay channels. There were three large operations on **Spruce Creek**; Kim Ferguson, Daniel Johnson, and Arrow Mining Company Inc. Kim Ferguson and Arrow Mining Company Inc. worked near the lower end of the creek and the Blue Canyon area, respectively, using "New Zealand" floating plant technology. This type of plant - a trommel, sluice and stacking conveyor mounted on pontoons - is extremely efficient in shallow ground as it requires only an excavator and two people to mine and process 1000 cubic metres per day. The plant and settling pond progress through the mining area as pay gravel is excavated in front and the stacking conveyor is used to place the coarse tailings behind. Daniel Johnson used large, conventional mining equipment and a sophisticated recirculating jig plant to recover gold down to 400 mesh from thick fluvioglacial and Tertiary gravels. In this operation, large pumps were used extensively to move pay gravel to the plant and to reclaim pits by backfilling them with tailings. On **McKee Creek**, West Coast Paving Co. Ltd. completed an extensive 3-year program of mining that included Eldorado Creek and McKee Creek above the Eldorado Creek confluence. The placer mining uncovered new bedrock exposures consisting of a mariposite-rich shear zone and clay-altered hydrothermal breccia.

There was one significant development during 1998 in a previously unexploited watershed. Turn Creek Resources Ltd. began work on a potentially large project on **Turn Creek**, approximately 50 kilometres east of the closest existing placer operation. Access to the property will be by a snow-road and mining, to start in 1999, will employ "New Zealand" floater technology.

INDUSTRIAL MINERAL AND GEMSTONE OPERATIONS

Cassiar Mining Inc., wholly owned by Minroc Mines Inc., began operation of a pilot plant to process tailings from the former **Cassiar** mine, using patented wet-milling technology. A total of 20 tonnes of chrysotile fibre was shipped before shut down on October 20. The 17 000 000-tonne tailings stockpile is estimated to contain 4.2% fibre, but the average from three working sites is 10% fibre (D. Caddy, pers. comm.). The company has marketing agreements with Japanese and European buyers, and hopes to expand to commercial production of 18 000 tonnes per year by mid-1999.

Fireside Minerals Inc. mined 17 000 tonnes from the West Bear pit on the **Fireside** deposit (94M 003) 125 kilometres east of Watson Lake. Crushing and sorting by jigs resulted in recovery of 11 500 tonnes of barite which was trucked to Watson Lake for grinding and bagging. The barite was marketed primarily to the Alaskan oil drilling industry. After mining, eight short, angle holes were drilled beneath the West Bear pit and its faulted extension (East Bear) to provide data for next year's mining plan. The Bear is a vertically dipping vein of coarse white barite and lesser dolomite. Siltstone beds within Kechika(?) Group shale contain up to 15% diagenetic barite and are probably the source of the Bear and other veins.

Contracted by Cassiar Chrysotile Inc., Jedway Enterprises Ltd. recovered about 50 tonnes of jade from the **Cassiar** mine waste-rock dump. Jade at Cassiar is formed where argillite has been thrust over serpentinite. Elsewhere it was a quiet year in the production of jade in northwest British Columbia as there was no mining at the Serpentine Lake and Kutcho deposits by The Jade West Group.

EXPLORATION PROJECTS (BY CAMP)

BABINE CAMP

Following two years of drilling at **Hearne Hill** (93M 006), Booker Gold Explorations Ltd. announced a geological resource in the breccia zones of 4.23 million tonnes at a grade of 0.60% Cu and 0.186 g/t Au, based on 143 core holes. In 1998 the company drilled three holes in the middle of the **Morrison** (93M 007) porphyry copper deposit. NQ core (4.75-cm diameter) was recovered to provide a better estimate of gold grade than was obtained by Noranda Inc. which drilled 65 AQ (2.7-cm diameter) and BQ (3.65-cm diameter) core holes in 1963-1973 and estimated 190 million tonnes containing 0.40% Cu and 0.20 g/t Au. The Noranda core was not systematically analyzed for gold. The determination was made on a composite of selected sample pulps. Booker

Gold's three holes average 0.48% Cu and 0.26 g/t Au, a gold to copper ratio similar to Noranda's estimate.

Between Granisle and Topley, Hudson Bay Exploration & Development Company Ltd. prospected the **Ful**, **Mor**, **Kut** and **Len** claims which were staked on airborne conductors in areas of extensive overburden. The target is (volcanogenic) massive sulphide deposits. The KUT anomaly was discounted because the claims were found to be underlain by Tertiary volcanic rocks (V. Sidic, pers. comm.). Grid-controlled ground EM and soil geochemical surveys were done on the other properties and drilling may follow in 1999.

D. L. Groot Logging Company explored the **Tangle** claims, 20 kilometres northwest of Granisle. Chalcocite, with significant silver, occurs in old trenches in an overburden covered area. Underlying rocks include volcanic and sedimentary strata of the Hazelton and Skeena groups and an intrusion, the latter inferred from geophysics. Drill targets were selected from IP, magnetic and VLF-EM surveys but no significant intersections were obtained.

The **Bornite** (93K 067) property, 70 kilometres northeast of Burns Lake, and immediately north of the Mac molybdenum deposit, is underlain by Cache Creek Group volcanic and ultramafic rocks, limestone and argillite, skarn and gabbro dikes. Ursula Mowatt searched for the source of copper-nickel geochemical anomalies and the source of boulders containing bornite and chalcopyrite.

Steve Bell conducted soil geochemistry and self-potential surveys on the **Palomino** (93L 019) claims northwest of Perow. The focus of early exploration was an auriferous chalcopyrite-bearing shear vein. The vein is on the margin of a quartz feldspar porphyry dike with disseminated chalcopyrite and the area has not been well explored for porphyry copper mineralization.

TAHTSA CAMP, HOUSTON AREA

Imperial Metals optioned the Star claims near **Chisholm Lake** 45 kilometres southwest of Houston from prospectors Ed and Gerry Westgarde and then staked a block of 200 units as the CL claims. Disseminated and stockwork chalcopyrite, with very little pyrite, occurs in relatively fresh, angular granodiorite boulders on a new logging road. Texturally and mineralogically the boulders appear similar to the late Cretaceous Bulkley stocks. Imperial Metals drilled a 2-kilometre fence of percussion holes in an area of subdued relief with mineralized boulders and sparse outcrop. Highest grade copper intersections were obtained 900 metres west of the original discovery, suggesting the mineralized boulders may have been glacially transported from a nearby source (P. McAndless, pers. comm.). The company also completed an IP survey on the **Whiting** (93E 112) porphyry prospect near the Huckleberry mine.

Bob Hamblin and Bruce Hobson staked the **Shea** claims on a newly exposed area of porphyry-style fracturing and veining in altered granodiorite and adjacent chloritized Hazelton Group volcanic rocks near the Thautil River 45 kilometres west of Houston (Figure 4). Minor amounts of chalcopyrite and molybdenite occur over a 1.5-kilometre length of new logging road through the alteration zone, which appears to be controlled by an east-northeast-trending fault.

A discovery of precious opal in the Whitesail Range, 10 kilometres south of Huckleberry mine, was staked as the **Northern Lights** claim and explored by Bruce Holden and partners (Figure 7). Agate, common and precious opal occur as vesicle fillings in basalt flows and matrix replacement in basaltic lahar of the Ootsa Lake Group. The precious opal has very good play of colour. The prospector-owners mined and sorted material by hand and then removed 800 kilograms from the site by helicopter to test stability of the opal and its carving characteristics for gemstone marketing. One type of instability of concern is crazing, the term used for loss of non-chemically bound water from the silica structure of precious opal, manifest by formation of minute cracks in the gemstone and loss of colour.

Figure 7. Northern Lights precious opal camp; prospectors Larry Hamula (second from left), Randy Lord (second from right) and Bruce Holden (right) are visited by George Simandl (left) and Francois Bernolles (centre) of the B.C. Geological Survey

SMITHERS CAMP

The **Telkwa** thermal coal deposits (93L 156) were acquired by Luscar Ltd. through its acquisition of Manalta Coal Ltd. Advanced exploration and field studies were completed for the Project Report under the

Environmental Assessment Act. In-fill drilling east of Goathorn Creek extended the Pit 3 deposit to the north and east. Five large-diameter holes were cored in the Tenas deposit to provide information about washability and sulphur liberation. Three holes were drilled to provide samples for acid/base accounting. Overburden trenches were dug for geotechnical purposes along the proposed coal haul road, the plant site and coal load-out. Production of 1.5 million tonnes of clean coal per year is proposed, that will be shipped by rail to Prince Rupert for the export market. Blending of Telkwa coal with coal from Luscar mines in northern Alberta would be mutually beneficial by upgrading the thermal rating of Albertan coal and lowering the sulphur content of Telkwa coal.

Del Santo (93L 025) is a volcanogenic massive sulphide prospect 35 kilometres southeast of Smithers explored by Telkwa Gold Corporation with six trenches and four drill holes. From 1967 to 1970 Del Santo was explored by Falconbridge Nickel Mines Ltd. and Bovan Mines Ltd. by bulldozer trenching, geochemical and geophysical surveys and 82 metres of drilling in four holes. The property is underlain by Nilkitkwa Formation of the Hazelton Group. Crudely banded chalcopyrite, magnetite, pyrrhotite and sphalerite occur with manganiferous chert and limestone at the stratigraphic contact between basaltic andesite and a thin quartz-eye rhyolite which is in turn overlain by thin bedded siltstone. Trench 1 assayed 2.11% Cu and 231 g/t Ag across 5.2 metres but the grade in drill holes is lower. Drill core from beneath the trenches reveals that the exhalative sequence was invaded by subvolcanic andesite which caused formation of epidote and disrupted continuity. Telkwa Gold traced the mineralized horizon by geological mapping and found strong magnetic and EM anomalies extending 500 metres north of the showing.

The **Big Onion** (93L 124) porphyry copper prospect (Figure 8), 16 kilometres east of Smithers, was explored by Consolidated Magna Ventures Ltd. The deposit was delineated by Canadian Superior Explorations Ltd. which calculated a total geological resource of 94 million tonnes containing 0.42% Cu and 0.012% Mo in 1977. Mineralization, with a substantial supergene overprint, is associated with dike-like quartz feldspar and quartz diorite porphyritic intrusions which trend northeast and are segmented by northwesterly faults. Intrusive rocks at Big Onion invade Hazelton Group strata and give radiometric ages ranging from mid-Cretaceous to early Tertiary. A fault with apparent left-lateral offset truncates the known southwest limit of the deposit. Consolidated Magna re-established IP anomalies and drilled six holes in search of the faulted extension. Two holes 200 metres apart intersected strongly altered porphyry with heavily disseminated pyrite and minor chalcopyrite. This opens a strike length of two kilometres in overburden-covered terrain where continued drilling is warranted to search for expansion of the mineralized zone.

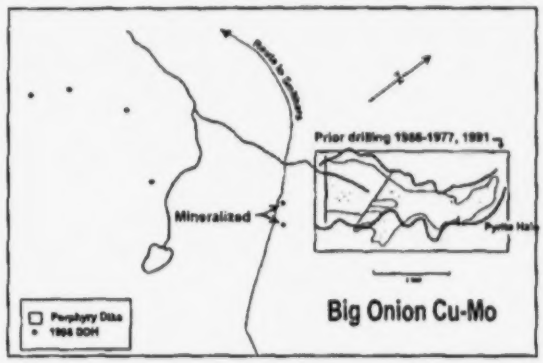

Figure 8. Big Onion porphyry copper deposit showing two step-out holes which extend the mineralized zone.

The development study of the **Yorke-Hardy** (93L 110, Glacier Gulch) porphyry molybdenum deposit near Smithers, by Verdstone Gold Corporation and Molycor Gold Corporation, was delayed due to the low molybdenum price. In 1981 Climax Molybdenum Corporation estimated a resource of 22.7 million tonnes grading 0.240% Mo within a larger deposit of 138.3 million tonnes of 0.151% Mo. Verdstone and Molycor propose to develop the higher grade zone by driving a new 4.5-kilometre adit from the southwest side of Hudson Bay Mountain, so that the mill and tailings sites can be located away from residential and recreational development on the northeast side of the mountain.

Louise Lake (93L 079), 30 kilometres west of Smithers, is a high-level porphyry copper prospect with potential for an enargite-gold deposit. In 1992 Equity Silver Mines Ltd. drilled a hole near the edge of a 1000by500 metre IP anomaly which intersected a 2.9-metre interval grading 1.46% Cu, 1.15% Zn, 121 g/t Ag and 1.92 g/t Au. In 1998 Global Mineral and Chemical Ltd. drilled three holes to further test the anomaly. The holes intersected pyroclastic dacite to rhyolite intruded by a fine-grained feldspathic rock that is pervasively altered to sericite and pyrite. The sequence is similar to volcanic rocks at the Equity Silver deposit.

Teck Corporation searched for gold in the **Kit** (93L 076) porphyry prospect at the head of Kitsuns Creek, 45 kilometres northwest of Smithers. A Bulkley stock, 0.5 by 2.5 kilometres in size, was explored by Mastodon-Highland Bell Mines Limited in 1968. A drill hole intersected 0.6% Cu and 100 to 400 ppb Au over 30 metres. Surface sampling by Teck found sulphide veins in Skeena Group sedimentary rocks are enriched in gold.

Prospectors Robin Day and Larry Hewitt continued exploration of the **Zymo** (93L 324) porphyry prospect 50 kilometres west of Smithers, in the same highly prospective area as the Kit and Louise Lake properties. A

strong copper soil anomaly overlies a high-level feldspathic intrusion that is altered to sericite and pyrite.

UPPER SKEENA DISTRICT

On the **Jake** (94D 061) claims, 105 kilometres north of Hazelton, Teck Corporation found gold enrichment in a previously explored porphyry copper prospect (Figure 9). *Canadian Superior Exploration Ltd. and Cities Service* Minerals Corporation investigated the area, known then as the "In" property, between 1973 and 1977. Porphyry mineralization is associated with a biotite-hornblende monzonite dike swarm that trends northeast and is divided into the Jake north and Jake south zones by fault. The fault is a deeply incised topographic feature which affords a depth profile of the porphyry system. Grid sampling by Teck shows Jake north has elevated levels of Cu, Mo, Zn and Pb. Jake south, apparently at a higher structural level, is enriched in Au, Ag, Bi and As (*S. Smith, R. Farmer, pers. comm.*). *The gold-anomalous* zones trend north and northwest. Continued exploration is anticipated.

Figure 9. Teck geologists Andy Betmanis (left) and Scott Smith (standing) inspect old core on the Jake property with Tom Schroeter, B.C. Geological Survey.

NORTH COAST AREA

Bishop Resources Inc. prospected and collected stream sediment samples from its extensive property in the northern part of the Ecstall massive sulphide belt. **Scotia North** (103I 007), **Scotia South** and **Ecstall North** comprise 425 units. The Ecstall belt consists of folded and metamorphosed mid-Paleozoic volcanic and sedimentary rocks preserved as a 100-kilometre-long roof pendant in the Coast Plutonic Complex.

QUEEN CHARLOTTE ISLANDS

Misty Mountain Gold Limited extracted a 4- tonne sample from the Specogna (103F 034) gold deposit on the **Harmony** property 15 kilometres south of Port Clements. The sample permits further study of metallurgical recovery. Testwork in 1997 achieved up to 86% gold recovery based on biological oxidation of coarsely crushed material, followed by a 30-day column leach with ammonium thiosulphate. The Specogna deposit is one of the largest undeveloped gold resources in British Columbia, 52.7 million tonnes containing 1.70 g/t Au at a cutoff grade of 0.8 g/t and 1.2:1 waste to ore ratio. In December, four drill holes investigated an IP anomaly that extends 500 metres north of the Specogna deposit, adjacent to the ore-controlling Sandspit fault. Assay results are not available at time of writing, but the IP response is attributed to a flat-lying, pyritic and silicified mudfow unit.

STEWART CAMP

Near American Creek, north of Stewart, Ranmar Ventures Ltd. mined and shipped 180 tonnes of ore from a surface cut on the High Grade vein on the **Mountain Boy** (104A 011) property. The Mann (No. 1) vein and High Grade (No. 2) vein contain quartz, barite and calcite, mineralized with sphalerite, galena, chalcopyrite and, especially in the High Grade silver vein, stromeyerite and pyrargyrite.

ISKUT CAMP

The focus of work by Homestake Canada Inc. on the large **Corey** property (**PRU** block, 104B 011) was south of Sulphurets Creek at its confluence with the Unuk River. East-dipping andesite, mudstone and rhyolite, possibly repeated by faulting, are overlain by pillow basalt on the Cumberland grid. The stratigraphic level is analogous to Eskay Creek but unlike the distal, extensional setting at Eskay, Cumberland-grid rhyolite is interpreted to be vent-proximal with a thick epiclastic accumulation (J. Moors, pers. comm.). Brittle-fractured mudstone, with introduced pyrite is strongly anomalous in mercury, arsenic and antimony, and weak to strongly anomalous in gold and silver. Four drill holes tested rhyolite-mudstone contacts but the only mineralized intercept was an arsenopyrite-galena vein, 40 cm wide, that assayed 1735 g/t Ag. A single drill hole by Homestake in 1997, north of Sulphurets Creek on the Bench grid, demonstrated a faulted contact between pillow basalt and footwall andesite, i.e. footwall rhyolite and the contact mudstone horizon are missing. Further north along the Unuk River, on the Battlement grid, rhyolite and pillow basalt are present but paleontological evidence indicates the mudstone there is older than at Eskay Creek.

On the **Kenrich** block of the **Corey** property, Kenrich Mining Corp. mapped the HSOV showing near the head of Mandy Creek, east of Mount Madge. Bedded marcasite occurs at the structural top of Salmon River Formation mudstone and is overlain by flow-banded to clastic rhyolite in what is interpreted by the company to be an overturned sequence. Soils and rocks are anomalous in silver, arsenic and locally in lead, zinc and copper.

Homestake explored the **Club** and **PBR** (Pillow Basalt Ridge) claims for Eskay Creek style mineralization (M. Vaskovic, pers. comm.). The Club showing consists of pyrite at a contact between andesite and siltstone which is anomalous in mercury, antimony and arsenic, but not gold. A massive pyrite boulder found elsewhere on the property also contains only background amounts of gold. On PBR, Homestake investigated several RGS (regional silt geochemical survey) anomalies in an area underlain by stratigraphy correlative with Eskay Creek. Pillow basalt is overlain directly by Bowser Lake Group sedimentary rocks and the prospective Salmon River mudstone is absent. No additional work is planned on either claim group.

On the **Quill** property on McQuillan Ridge, 22 kilometres south of the Eskay Creek mine, Allan St. James delineated a VLF-EM conductor beneath an area of boulders of vein quartz carrying chalcopyrite. Grab samples of the boulders assay 30 to 60 g/t Au. The boulder showing occurs where a Jurassic diorite intrudes Stuhini and Unuk River formation volcanic and sedimentary rocks, a geologic setting similar to the Snip gold deposit. Petra Resource Corporation optioned the property.

On the **RDN** claims, 25 kilometres west of Bob Quinn, geological mapping by Rimfire Minerals Corporation established a close comparison in geological setting and style of mineralization to the Eskay Creek deposit. The claims straddle the Forrest-Kerr fault, interpreted to be a reactivated Jurassic structure which controlled emplacement of plutons and eruption of pillow basalt. At the Marcasite Gossan showing, dacite shows textural evidence of having been erupted into unconsolidated limy siltstone. An irregular marcasite-pyrobitumen vein network invades the dacite-siltstone peperite and is overlain by pillow basalt. Belemnite fossils in the limy siltstone are coated with radiating overgrowths of coarse marcasite and provide dramatic evidence of open-space mineral growth. A boulder of stratiform clastic pyrite, found nearby, shows graded bedding and rip-up chips of black mudstone, textures similar to those associated with the 21B deposit at Eskay Creek. Geochemical response of Eskay Creek indicator elements (Ag, Au, Hg, Sb, As, Pb and Zn) in and above the stockwork zone is erratic but locally strong. Two kilometres north along strike, soils in an area measuring 100 by 450 metres are anomalous in gold, arsenic, lead and silver. Near the anomaly, a prominent exposure of sericite and pyritized rhyolite is reminiscent of the 21 zone felsite bluff at Eskay Creek. A fly-in excavator was used to trench the soil anomaly, but the machine was unable to reach bedrock.

On the **Bronson Slope** (104B 077) property, International Skyline Gold Corporation under agreement with Homestake Canada Inc., will finance the extension of the Snip mine 412 drift onto Skyline's claims in order to follow up on an exploration drill hole intersection of 15.8 g/t Au over 2.0 metres. The intercept is 400 metres below the Highwall gold zone which consists of disseminated and stockwork pyrite and grades 0.58 g/t Au over a 70-metre width. The company theorizes the Highwall zone is the surface expression of structurally controlled, high-grade vein(s) at depth.

STIKINE DISTRICT

On Todagin Mountain, 17 kilometres southeast of Iskut village, Homestake Canada Inc. evaluated the **Gin** (104H 031) property after work by the B.C. Geological Survey identified stratigraphy correlative with the Eskay Creek deposit. Hazelton Group rhyolite is intercalated with and overlain by pillow basalt, in turn capped by Bowser Lake Group clastic sedimentary rocks. Detailed rock and soil geochemistry failed to detect anomalies in Eskay Creek signature elements.

North of Telegraph Creek, Dan Ethier worked on his **Limpoke** Creek property (104G 001), a sheeted quartz-chalcopyrite-magnetite vein stockwork in potassic altered porphyritic syenite comparable to Galore Creek. Veining is parallel to the north-northeast-trending faulted contact with the Limpoke hornblende diorite pluton. Locally, the vein zone contains up to 30 g/t Au over 1 metre.

TURNAGAIN DISTRICT

Boliden Westmin Resources Limited undertook grassroots exploration in Devono-Mississippian schist and gneiss on the **Sail** claims 80 kilometres northeast of Dease Lake. The principal objective was to locate the source of massive pyrrhotite-chalcopyrite float, grading up to 8% Cu in grab samples, taken from a scree slope last year. The local stratagraphic succession appears to be an overturned sequence of hornblende-plagioclase amphibolite (mafic volcanic rock), pyritic quartz sericite schist (rhyolite) and laminated quartz-biotite gneiss (thin bedded siltstone). The high-grade copper was traced to its source at the Slot showing, a fault controlled vein in a cliff of mafic metavolcanic rock. Four other showings were found, of which the Zinc and South Slope showings are stratabound and have characteristics of volcanogenic mineralization. Additional claims were staked, enlarging the property to 140 units. These rocks have significant extent as prospectors Gerry Diakow and John Hope

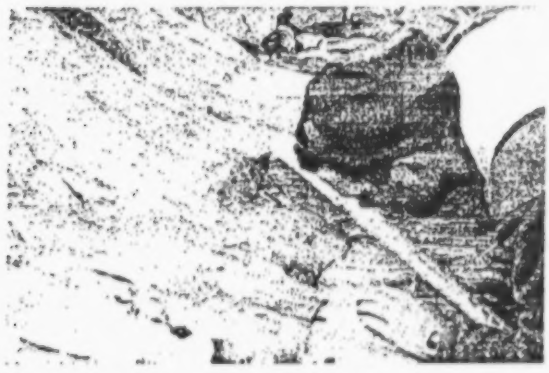

Figure 9. Boliden Westmin Geologist Ken Gibson examines meta-sedimentary gneiss on the Sail claims.

explored similar metavolcanic gneiss on the **Beady** claims 70 kilometres to the east, that are mineralized with stratabound pyrite and trace chalcopyrite. Similar metamorphic rocks also occur near Swan Lake, in the Rancheria area, where Steve Traynor is re-appraising the volcanogenic setting of the **Arsenault** (104O 011) showingThe **Cub** claims (Turnagain Nickel, 104I 014, 119, 120), 70 kilometres east of Dease Lake, were drilled by Bren-Mar Resources Ltd. to evaluate the nickel content of the Turnagain ultramafic complex. Drill hole 98-2 intersected 0.25% Ni and 131 ppm Co over 194.7 metres and is representative of results obtained from the 1998 program. Nickel occurs in silicate and sulphide minerals, the latter comprising sparsely disseminated pyrrhotite and pentlandite in serpentinized peridotite. Sulphide content is generally less than 1% but locally amounts to 15%. A bore-hole pulse EM survey was done in search of higher grade sulphide zones.

The Cry Lake Syndicate staked six properties in the Cry Lake area in 1996, based on silt geochemical data generated by the B.C. Geological Survey. In 1998 the syndicate confirmed high nickel, cobalt, gold and zinc (to 7000 ppm) in stream silt on the **Sun** property. The zinc anomalies correspond to an area underlain by Earn Group distal turbidite. The other anomalies are underlain by ultramafic rocks.

KECHIKA DISTRICT

Tizard Explorations Inc. allowed eight large claim blocks, comprising 1800 units and located 20 to 100 kilometres southeast of Watson Lake, to lapse. KRL Resources Corporation, which had explored the claims for Tizard, re-staked 50 **Ox** claims to cover geochemical and geophysical anomalies outside the Muskwa-Kechika special management zone. The target is a volcanic or sedimentary massive sulphide deposit.

CASSIAR CAMP

Retread Resources evaluated the **Cassiar Silver** property for Eveready Resources Corporation (a private, Calgary-based company) by surface and underground geological mapping, trench sampling and diamond drilling eight holes. The property covers a series of replacement vein, manto or exoskarn lead-zinc-silver showings (104P 006, 040, 044, 080, 081, 082) that extend 4 kilometres north and south of the Cassiar townsite and occur within Lower Cambrian Rosella Formation limestone, 500 to 1000 metres from the Cretaceous Cassiar batholith. The company estimates a resource in the renamed McMullen zone (formerly Magno) of 446 700 tonnes grading 111 g/t Ag, 3.7% Pb and 4.2% Zn based on holes drilled by Balfour Mining Ltd. in 1976. Eight holes drilled in 1998 confirm grade and continuity in the McMullen zone (D. Nikols, pers. comm.) but results were not released. Trenching on the D zone failed to reach bedrock. The company plans underground rehabilitation and surface work next year.

The **Keystone** (104J 012) property on Thibert Creek was drilled by Nu-Lite Industries Ltd. Thibert Creek has yielded substantial placer gold. Lode gold is associated with vein quartz and listwanite alteration in tectonically interleaved serpentinite and black phyllite in a major fault zone (J. Kowalchuk, pers. comm.). The ultramafic-hosted zone dips 60° south and is anomalous in gold, arsenic and antimony, but no values of economic significance were encountered.

RANCHERIA CAMP

Silvertip Mining Corporation, a wholly owned subsidiary of Imperial Metals Corporation, submitted an application to the Environmental Assessment Office to initiate the review process to approve or reject mine development for the **Silvertip**, formerly Midway deposit (104O 038). The deposit, estimated to contain 2.57 million tonnes at a grade of 325 g/t Ag, 6.4% Pb, 8.8% Zn and 0.63 g/t Au, would be mined by a combination of open-pit and underground methods. A dense media separation (DMS) circuit is planned to upgrade run of mine material, followed by conventional milling at 1500 to 2000 tonnes per day. Mineralization consists of irregular shaped mantos in McDame Group limestone below a regional Upper Devonian unconformity. The company considers potential for additional ore to be excellent but continued surface exploration is hampered by several factors: surface topography which necessitates long drill holes, extremely difficult drilling conditions in the Earn Group hangingwall rocks and at the underlying unconformity, and the small size and irregular shape of the mineralized zones. A deep-penetrating CSAMT survey was done to detect possible sulphide zones and guide future drilling. Sandpile Group dolomitic sandstone beneath the McDame limestone will also be tested when

exploration drilling is resumed. Other work focused on approval requirements and included geotechnical drilling of the tailings impoundment site and evaluation of Earn Group waste rock; pyrite distribution and its rate of weathering and zinc dissolution.

Beryllium and tungsten in the **Logtung** (104O 016) porphyry system are under investigation by Archer Cathro & Associates (1981) Ltd. The Logtung deposit, containing 162 million tonnes at a grade of 0.03% Mo and 0.10% Wo, is immediately north of the British Columbia-Yukon border. Archer Cathro acquired the property by staking when previous claims were allowed to expire. Beryl, as a source of beryllium, may be present in sufficient amounts to make the deposit economically viable. Beryl occurs in the molybdenum-tungsten zone, and also peripherally in quartz veins with wolframite. These are developed primarily in metasedimentary schist up to 2 kilometres south of the deposit, in an area not explored by drilling, on the B.C. side of the border.

TAKU - TULSEQUAH CAMP

Redfern Resources Ltd. applied for a Special Use Permit (SUP) from the Ministry of Forests and authorization under the B.C. Mining Right of Way Act to access the proposed **Tulsequah Chief** (104K 002) mine. The road will be single lane, radio-controlled and gated to control usage south of Kilometre 110 (O'Donnel River bridge).

The **Red Cap** (104K 010, 053, 085) property, near the Taku River 100 kilometres south of Atlin, was explored for cobalt and gold by Xplorerer Gold Corp. Red Cap is a telescoped porphyry system with an alteration halo and gossan that extend nearly 2 kilometres out from a small granodiorite stock, dated at 87 Ma (M. Mihalynuk, pers. comm.). The intruded rocks are upper Triassic Stuhini Formation andesite lapilli tuff and Jurassic Takwahoni volcanic conglomerate. Cobalt and gold occur in small lenses of pyrrhotite, cobaltite(?), arsenopyrite, chalcopyrite and sphalerite in bleached and silicified andesite hornfels, with associated epidote and other calcsilicates. On surface, the altered andesite resembles rhyolite, and mineralization was initially misclassified as volcanogenic, but drill core reveals the rock's parentage. Arsenopyrite also occurs as veins within fractured chlorite-epidote-pyrrhotite hornfels. The work focused east of the stock, on a spur ridge of Mount Lester Jones. Xplorerer Gold is a private company and results of the eleven holes it drilled at Red Cap have not been released. The company also owns the nearby Erickson-Ashby high-grade stratabound zinc prospect 4 kilometres southeast of the Big Bull volcanogenic massive sulphide deposit on the Tulsequah Chief property. Reclamation of prior exploration activity and reappraisal of exploration targets were carried out.

The **Thorn** (104K 031) high-sulphidation enargite-gold prospect, near the Sutlahini River was optioned from Clive Aspinall by Kohima Pacific Gold Corp. An unpublished age determination gives a date of 87 Ma for the northwest-trending quartz feldspar porphyry body associated with mineralization (M. Mihalynuk, pers. comm.). Prospecting resulted in discovery of a new enargite-bearing outcrop that assayed 6.9% Cu, 1 g/t Au and 180 g/t Ag over 0.5 metre. Alteration mapping with PIMA (portable infrared mineral analyzer) determined the dominant phyllosilicate minerals property are pyrophyllite, diaspore and dickite.

ACKNOWLEDGEMENTS

I thank the many geologists and prospectors for their hospitality while showing me their properties, and kindly providing information. I am also grateful for the drafting and graphics assistance of Sandee Ennis.

NORTHEAST-CENTRAL REGION

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SUMMARY

The mining and mineral exploration industry in northeast-central British Columbia endured a turbulent 1998. The highlight of activity in the region was the opening the Kemess South gold-copper mine in the Toodoggone camp which, in spite of the tough economic times, reached commercial production in October. Depressed metal prices and lower than anticipated operating income led to the closure of two of the region's four operating metal mines, the QR gold mine and Gibraltar copper-molybdenum mine, both located in the Cariboo. The closure of a third Cariboo-area operation, the Mount Polley copper-gold mine, was seriously considered, but averted.

Weakening demand for hard coking coal in Asia drove prices for that commodity down also. Based on contracts negotiated in 1997 with the Japanese steel industry, the Quintette and Bullmoose mines near Tumbler Ridge will supply 1.35 million fewer tonnes of metallurgical coal per annum, at significantly lower prices, than stipulated in past contracts. Bulk sampling proceeded at the Willow Creek property, a permitted thermal/semi-soft coking coal project west of Chetwynd.

Virtually all exploration trend indicators were negative. Total mineral exploration expenditures decreased to an estimated $4.7 million, down a staggering 66% from 1997. Lower commodity prices and closure plans had an adverse affect on the level of minesite exploration, which fell to approximately $0.66 million, down from $2.79 million in 1997. There were 15 major exploration projects in the region, 13 fewer than in 1997. Junior mining companies, recently the backbone of both advanced stage and grassroots exploration in the province, continued to have difficulty attracting risk capital for British Columbia projects.

Despite the dramatic downturn in the level of exploration there were several highlights. They include:

- Successful deep diamond-drilling at the Tsacha epithermal vein prospect in the Nechako Plateau.
- Encouraging drill assay results and a new porphyry copper-gold showing at Indata.
- Continued pursuit of auriferous vein, skarn and manto-style mineralization at Lustdust.
- Discovery of several porphyry copper-molybdenum prospects in the Granite Mountain area near Gibraltar.
- Several encouraging grassroots discoveries in the Omineca (Firesteel and Fran), Babine Lake (Fort), and Cariboo (Bow and Simlock Creek) regions.

METAL MINES

There were four operating metal mines in the region in 1998; three in the Cariboo (QR, Gibraltar and Mount Polley) and one (Kemess South) in the northern Omineca. The highlight of mining activity in the region was the commissioning of the Kemess South gold-copper mine in the Toodoggone. However, declining copper and gold prices led to lower than anticipated revenues at each operation and resulted in closures of the QR gold mine and the Gibraltar copper-molybdenum mine. Difficulty in servicing the debt accrued for construction of Mount Polley and Kemess South led to the revision of operating costs and/or debt servicing arrangements. Production statistics for 1997 and 1998 (estimated) are listed in Table 1.

KEMESS SOUTH

The highlight of mining activity in the region was the commissioning of the **Kemess South** open-pit gold-copper mine (Photos 1 and 2), located 300 kilometres northwest of Mackenzie. Construction of the $480 million mine, owned and operated by Royal Oak Mines Inc., was completed in mid-May, 1998. The mine reached commercial production on October 7, 1998. At start-up, the mineable reserve of the Kemess South deposit was 200 million tonnes grading 0.63 g/t Au and 0.22% Cu.

The deposit is hosted by the Early Jurassic Maple Leaf intrusion, a gently inclined sheet of quartz monzodiorite. The orebody measures 1700 metres long by 650 metres wide and ranges from 100 metres to over 290 metres thick. A blanket of copper-enriched supergene ore, containing native copper, overlies hypogene ore which comprises 80% of the deposit. During start-up, the mill processed hypogene and supergene ore in separate batches in order to fine-tune the mill for maximum metal recovery from the markedly different ore types. Metal recoveries of 86% for copper and 74% for gold were obtained from hypogene ore with average head grades

TABLE 1. PRODUCTION FROM LODE METAL MINES IN NORTHEAST-CENTRAL B.C.

Mine (owner)	1997 Tonnes Milled (thousands)	1997 Metals Produced	1998 (est) Tonnes Milled (thousands)	1998 (est) Metals Produced
Gibraltar *(Boliden Ltd.)*	*13 000*	*35 922 tonnes Cu, 164 tonnes Mo*	*12 390*	*33 896 tonnes Cu, 398 tonnes Mo*
QR *(Kinross Gold Corp.)*	*390*	*1274.2 kilograms Au, 327 kilograms Ag*	*66*	*337.4 kilograms Au*
Mount Polley *(Imperial Metals Corp.)*	*2450*	*555.7 kilograms Au, 3587 tonnes Cu*	*5830*	*3164 kilograms Au, 10 850 tonnes Cu*
Baker *(Sable Resources Ltd.)*	*2.1*	*35.8 kilograms Au, 4.5 tonnes Cu*	-	- -
Kemess South *(Royal Oak Mines Ltd.)*	-	- -	*7482*	*9690 tonnes Cu, 2393 kilograms Au*

of 0.22% Cu and 0.55 g/t Au. Metal recovery from supergene ore averaged 70% for copper and 75% for gold from head grades of 0.27% copper and 0.72 g/t Au. Cumulative production from Kemess South for the year, including the start-up phase, was an estimated 2393 kilograms of gold and 9690 tonnes of copper. The mill processed an average of 32 800 tonnes per day. Average annual production is forecast to be 7780 kilograms (250 000 oz) of gold and 272 000 tonnes (60 million lb) of copper, in concentrate form, over the minimum 16-year life of the mine. The mine employs approximately 320 workers and is accessible by air and road.

Royal Oak did not conduct any exploration on the Kemess South mine site in 1998. However, the company did complete a modest grid-based mapping and geochemical sampling program near several old skarn showings on Duncan Ridge, northwest of the mine on its **Kemess North** property.

MOUNT POLLEY

The **Mount Polley** copper-gold mine, owned jointly by Imperial Metals Corporation (55%) and Sumitomo Corporation of Japan (45%), is located 56 kilometres northeast of Williams Lake. Early in the year, Imperial Metals considered a temporary suspension of operations because of low commodity prices, that would have gone into effect on July 31, 1998. However, the company successfully negotiated an economic plan, sponsored by the province's Job Protection Commission, that will be in effect for the next two years. The result of the plan was a significant reduction in annual operating costs. Financial concessions included a reduction in the cost of hydroelectric power, property tax deferrals, and a 10% wage deferral from unionized workers and company employees. The mine directly employs 182 people.

The Mount Polley deposit consists of three zones, Cariboo, Bell and Springer that occur mainly in diorite and intrusion breccia of the Early Jurassic Polley stock. At start-up (September, 1997), the combined mineable ore reserve in the three zones was 82.3 million tonnes grading 0.3% Cu and 0.417 g/t Au. Early in 1998, mining took place in the north end of the Cariboo pit. However, with the drop in the price of gold, mining progressed southward to a copper oxide-rich area at the south end of the pit where the gold grades are consistently more than 0.5 g/t. Mill throughput averaged 16 000 tonnes per calendar day, but toward the end of the year daily rates exceeded 19 000 t/d. Metal recoveries averaged about 50% for copper and 70% for gold. In 1998 the mine produced about 3 164 kilograms (101 700 oz) of gold and 10 850 tonnes (23.9 million lb) of copper.

Detailed geological mapping of the Cariboo pit resulted in a better understanding of the features that control grade. Mapping and core re-logging enabled mine staff to model the orebody much more accurately than previously. Oxide ratios are significantly lower and better overall copper recoveries are expected. A total of nine diamond-drill holes tested the continuity of mineralization either at depth or across structures within the Cariboo pit boundaries. Information gained from this program may result in modification of the pit design in years ahead. A bulk sample from the Bell pit will be tested for metal recoveries.

QR

The **QR** gold mine, owned and operated by Kinross Gold Corporation, operated for the first quarter of 1998 and was then placed on full care and maintenance. Higher operating costs associated with underground mining, and a weakening gold price, contributed to the closure

Photo 1. Looking northeast across the Royal Oak Mines Inc. Kemess South mine development (September, 1998).

Photo 2. Close-up of starter pit development, Kemess South mine (September, 1998).

which had been announced in 1997. The QR deposit occurs in hornfelsed and propylitically altered Nicola Group volcanics within the thermal aureole of the Early Jurassic QR stock. Ore has been mined from three zones; open pits on the Main and West zones, and underground development of the Midwest zone. In 1998, mining took place on four levels of the Midwest zone. Mining stopped on March 31 and the mill processed its last ore in late April. For 1998, a total of 337.4 kilograms (12 133 oz) of gold were recovered from the processing of 66 000 tonnes of ore. An estimated 4000 kilograms (128 000 oz) of gold were recovered from 1 063 300 tonnes of ore during close to three years of production. Remaining open-pit and underground proven and probable reserves are 320 000 tonnes grading 5.08 g/t Au. Reclamation is in progress.

QR was the site of the largest exploration program in the region in 1997 and aggressive diamond drilling continued into early 1998, with the completion of more than 80 shallow holes. The focus of the program was to outline near-surface, open-pit reserves that would keep the mine in operation. Encouraging assay results from late 1997 led to concentrated drilling of a new discovery, the Northwest zone, just north of the West zone haul road. Drilling was unable to identify economic reserves, but did establish a resource of approximately 120 000 tonnes grading about 3.5 g/t Au.

GIBRALTAR

Near McLeese Lake, Boliden Limited became owner of the **Gibraltar** open-pit copper-molybdenum mine in January, 1998, through its takeover of Westmin Resources Limited. In March, Boliden completed an extensive review that concluded the Gibraltar mine was uneconomic and followed with an announcement that the mine would close in December. Closure would coincide with the exhaustion of reserves in the Gibraltar East pit. Rock stripping of the Pollyanna stage-4 pit was suspended in the spring to cut overall operating costs. However, a profitable first half of operations (primarily because mine management had presold 50% of its copper production at $US0.98/lb., arranged lower smelter charges and reduced operational costs) convinced Boliden to allow the mine management team to proceed with a restructuring plan. NGMT Resources Ltd. (New Gibraltar Management Team) was formed to take over ownership of the mine and Pollyanna rock stripping resumed. In mid-December, Boliden announced that NGMT was unable to arrange the required financing to sustain operations at Gibraltar. Mining and milling ceased in mid-December. The operation employs 278 workers who will focus on reclamation and general clean-up until they are laid off at the end of February, 1999.

In 1998 the mine produced approximately 32 238 tonnes of copper and 398 tonnes of molybdenum in concentrate, from 12.39 million tonnes of ore milled at an average rate of 35 380 tonnes per day. Mining was primarily in the Gibraltar East stage-3 pit. An additional 1658 tonnes of cathode copper was produced from the solvent extraction-electrowinning plant (SX-EW) by acid-leach processing of low-grade ore and oxide material. The total mineable sulphide ore reserve for the Gibraltar copper-molybdenum porphyry deposit, as of January 1, 1999, is 148 685 000 tonnes grading 0.305% Cu and 0.010% Mo. The total leachable ore reserve is 14 813 000 tonnes at an acid-soluble grade of 0.148% Cu.

The Gibraltar porphyry deposit occurs in the Early Triassic Granite Mountain batholith, a zoned subalkalic body that intrudes Permian Cache Creek Group rocks. Several orebodies occur within a broad, easterly trending zone of shearing and alteration. Exploration on the mine site consisted of a five-hole diamond drilling program that tested the GM zone, a porphyry copper-molybdenum target outlined by coincident IP and copper geochemical anomalies. Results were encouraging. United Gunn Resources Ltd. and Rio Algom Exploration Inc. conducted exploration on claims adjacent to the Gibraltar mine site and are reported on below.

OTHER METAL MINE DEVELOPMENTS

In the Toodoggone, Sable Resources Ltd. was permitted to mine up to 10 000 tonnes of gold-silver ore by open-pit methods from the near-surface JM deposit on its **Shasta** property. The orebody was confirmed with nine diamond-drill holes in 1998 and averages 12 g/t (0.35 oz/ton) gold-equivalent. While limited blasting proceeded, mining and milling was deferred until 1999.

The **Baker** gold mine, a small seasonal operation also located in the Toodoggone camp, is owned by Sable Resources Ltd. The Multinational 'B' vein deposit was effectively mined out in 1997. There was no production in 1998.

Reclamation of the **Lawyers** mine, owned and operated by Cheni Resources Inc., was completed in September, 1998. Production totaled 5328.7 kilograms (171 322 oz) of gold and 118 200 kilograms (3.8 million oz) of silver during the mines three years of operation (1989-1992). The Lawyers mill was also used to process ore from the nearby **Al** property which resulted in the recovery of 71.7 kilograms (2305 oz) of gold.

COAL MINES

There are two operating coal mines in the Northeast-Central Region. The Quintette and Bullmoose operations, both located near the town of Tumbler Ridge, produce metallurgical coal that is exported exclusively to Japan. In 1997, the two mines renegotiated their contracts with the Japanese steel industry that secured markets for their coal until March, 2003. It is reported that commencing in 1999, the Japanese will take 3 million tonnes annually

from Quintette and 1.55 million tonnes annually from Bullmoose. Unfortunately, the reduction in coal sales has resulted in significant layoffs at both operations.

The **Quintette** coal mine, operated by Teck Corporation, produced an estimated 3 million tonnes of clean metallurgical coal in 1998. Approximately one-third of that total was produced from the Little and Big Windy developments at Mount Babcock. Reserves in the Shikano, Wolverine and Deputy pits were exhausted during the year. The remaining mineable reserves are contained in the Babcock, Mesa and Mesa Extension areas. Clean coal reserves, at the end of 1998, are an estimated 18 million tonnes. The Babcock development is expected to produce 2 million tonnes of clean coal per annum for the next five years. The balance of 1 million tonnes per year will come from Mesa and Mesa Extension. A planned exploration program consisting of percussion and large-diameter core drilling, together with bulk sampling, on the Window area at Babcock, was postponed indefinitely.

The **Bullmoose** mine, 61% owned by Teck Corporation, produced an estimated 1.7 million tonnes of clean metallurgical coal during 1998, a slight decrease from the 1997 total of 1.85 million tonnes. Production is from the South Fork pit which, as of December 31, 1998, had 11.0 million run-of-mine tonnes remaining (sufficient until 2003). A 54-hole, 2000-metre reverse-circulation drilling program on the West Fork area ran from December, 1997 to January, 1998. Results did not warrant a new feasibility study of the West Fork deposit at this time. Development of the West Fork area would not trigger a review under new thresholds released in the revised Environmental Assessment Act.

PLACER GOLD MINING OPERATIONS

Placer activity was focused in four areas of the region, with most of the activity occurring in the Cariboo (Photo 3). Below is a list of the locations where larger operations took place in 1998.

- OMINECA: Slate Creek, Germansen River.
- HIXON AREA: Terry Creek.
- CARIBOO: Quesnel River, Lightning Creek, Cottonwood River, Alice Creek, Tregillus Creek, Beaver Pass Creek, Williams Creek, Summit Creek, Conglin Gulch.
- LIKELY AREA: Keithley Creek, 4 Mile Gulch, Cedar Creek, Spanish Mountain.

Gallery Resources Ltd. completed reclamation of the Hannandor pit, part of its large lease holdings on Lightning Creek.

Photo 3. Aerial view of the Noble Metal Group Incorporated placer gold operation near Keithley Creek (Ken MacDonald photo, August, 1998).

INDUSTRIAL MINERALS OPERATIONS

The **Nazko** lava-rock quarry, located 118 kilometres west of Quesnel, is owned and operated by Canada Pumice Corporation. In 1998, approximately 30 000 cubic yards of material were processed at the site, half of which was shipped to markets; the remainder was stockpiled at the site. The sized red, calico and black tephra has a range of industrial applications, including construction, landscaping and horticultural products. Radiosensitivity and seismic surveys conducted during the summer have expanded the geological reserves to an estimated 45 million tonnes.

Two small limestone quarries, **Giscome** and **Dahl Lake**, did not operate in 1998, but sold a limited amount of material from stockpiles to be used principally for landscaping. The Giscome quarry, 20 kilometres northeast of Prince George, is owned by Kode-Jerrat Quarries Ltd. The Dahl Lake limestone quarry, 50 kilometres southwest of Prince George, is owned by Northrock Industries Ltd.

The **Giscome** and **Ahbau** railroad ballast quarries supplied material for mainline routes in their respective areas.

FUTURE MINE DEVELOPMENTS

Placer Dome Inc. received an amendment to extend the Project Approval Certificate (PAC) for its **Mt. Milligan** porphyry copper-gold deposit for five years to 2003. A company review of the projects economic viability resulted in a decision to keep the development on hold.

Pine Valley Coal Ltd., (operator for the BCR Ventures Inc., Falls Mountain Coal Inc. and Mitsui Matsushima Canada Ltd. joint venture), received a PAC for its **Willow Creek** coal project from the province's Environmental Assessment Office on March 6, 1998. The property, located 45 kilometres west of Chetwynd, is in the process of being converted into a mine lease. The company hopes to start construction of a 900 000 tonnes per year open-pit coal mine in 1999. Capital cost of the project is an estimated $20 million. The operation would require a workforce of 110 during its 15-year mine life. The current in-place mineable reserve for the North and Central areas is 15.65 million tonnes of thermal and low-grade coking coal.

The low-volatile coal measures are in the upper and middle members of the Gething Formation, on the northeast limb of the Coal River anticline. During the year, large-diameter core-drilling generated two bulk samples for testing by potential customers. A 200-kilogram sample was collected for testing as a PCI (pulverized coal injection) coal and a 600-kilogram sample was evaluated for its carbonization characteristics and its applicability as a semi-soft coking coal. Pine Valley's immediate plans are to mine and ship 50 000 tonnes of low-ash coal from the South Peninsula area of the deposit to three potential buyers of PCI coal.

At the **Belcourt** property, 100 kilometres south of Quintette, Western Coal Corporation drilled a series of holes on the Holtslander reserve area to confirm general structure, coal seam thickness and basic coal quality data. A more detailed program is planned for 1999. Current reserves for the property are reported for the Red Deer (34.6 Mt), Holtslander (23.8 Mt) and Omega (44.8 million tonnes) areas.

EXPLORATION TRENDS

The estimate for 1998 exploration expenditures in the region is $4.7 million (Figure 1), just one-third of the 1997 total of $13.7 million. Likewise, the amount of exploration drilling decreased significantly, to approximately 28 300 metres (Figure 2).

Notice of Work submittals (NoW) for the year decreased 10% to 583 (Table 2). Most alarming however, was that most of the reduction was in the mineral exploration sector where a total of 115 mineral NoW

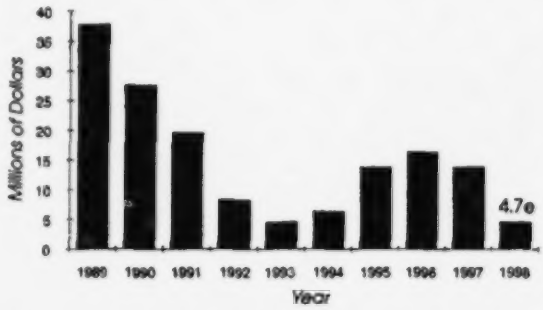

Figure 1. Annual exploration expenditures, Northeast-Central Region.

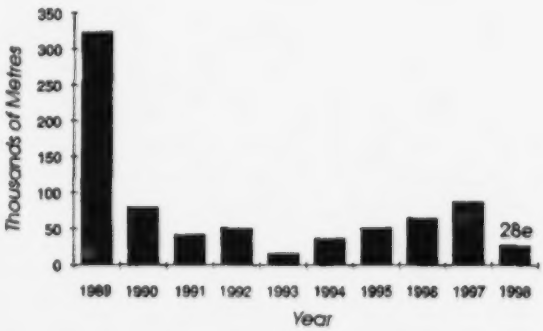

Figure 2. Annual exploration drilling, Northeast-Central Region.

were submitted, 49 fewer than in 1998. Exploration at active minesites decreased by approximately $2 million as operators tightened their belts. Junior mining companies continued to have great difficulty attracting risk capital for their British Columbia projects. Many of the larger budget, more advanced projects were either cancelled or significantly reduced. The level of grassroots exploration remained steady at very modest levels.

As in past years, the most popular targets in the region were gold-enriched porphyry copper deposits and gold vein systems (Figure 3). Overall, the level of exploration for most deposit types in the region was depressed. However, in the Cariboo, follow-up of mineralized float led to a modest increase in the level of exploration for volcanogenic massive sulphide (VMS) deposits in the Slide Mountain and Barkerville (Kootenay) terranes.

There were 15 major exploration projects (those that involve mechanical disturbance and expenditures exceeding $100,000), 10 of which took place in the Omineca Mining Division and 5 in the Cariboo Mining Division. Only one major exploration project was undertaken on an active minesite (QR). Major exploration projects in 1998 are listed in Table 3 and shown on Figure 4. These, and selected smaller projects, are briefly described below.

TABLE 2. NOTICE OF WORK (NOW) SUBMITTALS FOR PROJECTS IN NORTHEAST-CENTRAL B.C.

Type of NoW	Year			
	1995	1996	1997	1998
Mineral	221	184	164	115
Placer	498	440	415	407
Coal	3	4	5	5
Other	67	58	57	56
Total NoW submitted	789	686	641	583

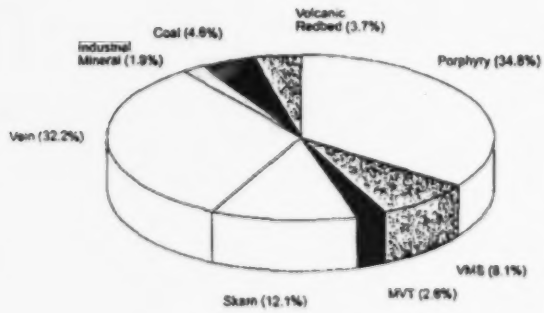

Figure 3. Exploration targets expressed as a percentage of total 1998 expenditures ($4.7 million) in Northeast-Central B.C.

EXPLORATION HIGHLIGHTS

GATAGA/KECHIKA TROUGH

There were no exploration projects in the Gataga/southern Kechika Trough region this year. This previously active sedex lead-zinc-silver-barite belt hosts the Cirque, Akie and Driftpile deposits and many prospects.

TOODOGGONE CAMP

The largest programs in the Toodoggone camp targeted epithermal vein systems on the JD and Chappelle properties, porphyry copper-gold mineralization on the Pine property, and porphyry copper and/or volcanic redbed copper mineralization on the Marmot property.

Project partners Antares Mining and Exploration Corp. and AGC Americas Gold Corp. completed two modest diamond drilling programs on their JD epithermal gold property, north of the Toodoggone River. Drilling explored the Creek zone, an epithermal vein system located 2.8 kilometres west-northwest of the main Finn zone. Last year's discovery hole (CZ97-08) intersected a 4-metre interval of semimassive to massive sulphide mineralization that graded 61.16 g/t Au, 92.3 g/t Ag, 1.34% Cu, 0.46% Pb and 11.7% Zn. The true width of the zone is not known. Early 1998 holes were drilled on section and intersected narrow veins and stringers comprising sphalerite-galena-chalcopyrite-pyrite in a gangue of calcite-epidote-chlorite+/-quartz. The latter holes confirmed the 170° strike of the zone and identified a parallel structure, the Orest zone. Assay results from the 11 holes drilled were mixed, however highest gold grades are associated with sphalerite-rich intervals. It is uncertain whether any exploration will take place on the property next year.

Sable Resources Ltd. explored several areas on its **Chappelle** claims which encompass the Baker mine. The company is encouraged by high-grade gold-silver float that was discovered north of the mined 'A' vein. The anomalous float (Ridge zone) may be related to a previously unidentified extension of the 'D' vein. Sable trenched the area, but could not locate the source of the vein mineralization amongst the intensely oxidized and fractured andesitic volcanic flows of the Takla Group. Eight diamond-drill holes were completed near the Multinational 'B' vein, but did not identify additional ore. Two holes tested the New zone and intersected

encouraging-looking quartz-sulphide vein and breccia mineralization that did not make ore grade. The company has proposed additional drilling and trenching for 1999.

Stealth Mining Corporation returned to the **Pine** property, 25 kilometres north of the Kemess mine, in 1998 to resume diamond drilling on its gold-enriched alkalic porphyry copper system. Seven holes were completed on the Pine zone, focusing on an area that last year generated bonanza-style gold grades (i.e. 3 m grading 36.17 g/t Au in hole P97-4) from subvertical zones comprising silicified breccia and multi-stage quartz veins. Assay results from this year's drilling were mixed, but there were several notable near-surface intersections that are suggestive of a late epithermal overprint of the porphyry copper system.

Reconnaissance work conducted by San Telmo Resources Ltd. in 1997 on the **Thor-Marmot** property in the McConnell Ranges, 25 kilometres south-southeast of the Kemess South mine, lead to a six-hole diamond drilling program in 1998. The drilling tested several targets on this volcanogenic redbed copper/porphyry copper prospect, but assay results from the first five holes were not encouraging. The last hole of the program, Mar 98-06, intersected sporadic zones of disseminated and fracture-controlled pyrite and chalcopyrite in a propylitically-altered granitic intrusion near the B-south zone.

Other porphyry prospects in the area that were briefly explored include the **Pil** and **Attycelley** properties of Electrum Resource Corp. and the **Brenda** property of Canasil Resources Inc..

A modest trenching program on the **Firesteel** lead-zinc-silver prospect, by partners Don Bragg and Dave Javorsky on behalf of Wheathills Resources Inc., located some interesting base metal mineralization west of the Firesteel River. Numerous trenches exposed encouraging stockworks of tetrahedrite-galena-sphalerite-pyrite in dolomitized and locally silicified limestone.

JOHANSON - AIKEN LAKES AREA

Starfield Resources Ltd. expanded on previous grid-based mapping, geochemical and geophysical surveys at the **Abe** porphyry copper-gold property (under option from Major General Resources Ltd.), located 5 kilometres south of Aiken Lake. The property is underlain primarily by syenite to diorite and pyroxenite of the Late Triassic to Early Cretaceous Hogem batholith. It hosts several flat-lying quartz vein showings that generally contain traces of pyrite, chalcopyrite, galena and specularite. This style of mineralization is quite distal from source and the potential for a significant porphyry system lies laterally or at depth. Starfield may drill the property in 1999.

Limited programs consisting of mapping, prospecting and geochemical sampling were carried out by Canasil Resources Inc. on its **Lil** and **Mat** properties northeast of Aiken Lake. Assays from chip sampling of narrow, high-grade silver-rich veins and breccia zones were as high as 1950 g/t (56.85 oz/ton) Ag over 0.65 metre.

Fox Geological Services Inc., on behalf of Phelps Dodge Corporation of Canada, Ltd., investigated numerous Regional Geochemical Survey (RGS) anomalies in the McConnell Creek map area (NTS 94D). This reconnaissance work identified an anomalous copper-zinc horizon within Triassic tuffaceous sedimentary rocks on the **Car** and **Rut** claims, and located a large angular slab of banded massive sulphide mineralization, a grab sample of which assayed 3170 ppb Au, 250 g/t Ag, 4.44% Cu and 3.48% Zn.

SWANNELL RANGES

There was no activity at the **Lorraine** porphyry copper-gold property, but owner Lysander Gold Corporation completed a revised mineral resource calculation based on all previous diamond drilling. The combined 'preliminary resource' for the Upper Main, Lower Main and Bishop zones is 32 million tonnes averaging 0.66% Cu, 0.17 g/t Au and 4.7 g/t Ag.

HOGEM RANGES

Clear Creek Resources Ltd. completed a ten-hole diamond drilling program on the Albert Lake porphyry copper prospect, on the **Indata** property just west of Albert Lake. The best intersection was from hole 4 which averaged 0.20% Cu and traces of molybdenum over 145.2 metres. Hole 9, drilled 120 metres to the southwest, intersected 58.3 metres grading 0.18% Cu. Mineralization consists of narrow intervals of fracture-controlled and disseminated chalcopyrite in propylitically altered to hornfelsed, fine-grained andesite flows. Late in the year, logging road construction across the claims resulted in new exposures of porphyry-style mineralization. Ten grab samples from a 100 metre by 225 metre area assayed an average of 1.04% Cu and 388 ppb Au.

Alpha Gold Corp. completed a 14-hole diamond drilling program on its **Lustdust** property, located north of Kwanika Creek, about 36 kilometres northeast of Takla Landing. The prospect is west of the Pinchi fault, in Permian Cache Creek Group limestone and mafic tuff near the margin of the Hogem batholith. The stratigraphic sequence is cut by a series of feldspar megacrystic dikes and sills that are related to a poorly exposed monzonite plug. Zones of hornfels, calcsilicate skarn and garnetite have developed within the thermal aureole of the stock. Styles of mineralization range from proximal skarns to central mantos to distal sulphosalt veins.

TABLE 3. MAJOR EXPLORATION PROJECTS, NORTHEAST-CENTRAL BRITISH COLUMBIA - 1998

Property (Operator)	Minfile Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Ace (Barker Minerals)	093A 142	Cariboo	93A/14	Cu, Au, Ag, Zn	VMS, vein	7 ddh, 1250 m
Bow (Eureka Resources)		Cariboo	93H/5E	Cu, Zn, Au, Ag	VMS	IP, mag, geochem
Buck (Pacific Star Resources)	093F 050	Omineca	93F/3E	Zn, Pb, Cu, Au	porphyry-related	7 ddh, 918 m
Cariboo Gold Quartz (Int'l Wayside Gold Mines)	093H 019	Cariboo	93H/4E	Au	mesothermal vein	17 ddh & 24 pdh, 2422 m; tr; geochem
Chappelle-Baker Mine (Sable Resources)	094E 026	Omineca	94E/6E	Au, Ag, Cu	epithermal vein	10 ddh, 750 m
Fawn-Malaput (Cascadia Int'l Res.)	093F 043	Omineca	93F/3E	Au, Ag	epithermal vein	7 ddh, 744 m
Fort (Eastfield Resources)	093K 093	Omineca	93K/11E	Cu, Mo	tectonic breccia	IP, geochem, map
Granite Mountain (United Gunn)		Cariboo	93B/9	Cu, Mo	porphyry	IP, geochem, map
Indata (Wildrose Resources)	093N 192	Omineca	93N/6W	Cu, Au, Mo	porphyry, vein	11 ddh, 1200 m; geochem
JD (Antares Mining / AGC Americas Gold Corp.)	094E 171	Omineca	94E/6E	Au	epithermal vein	11 ddh, 1973 m; IP
Marmot (San Telmo Resources)	094D 005	Omineca	94D/10E	Cu	porphyry / volc. redbed copper	6 ddh, 692 m
Lustdust (Alpha Gold)	093N 009	Omineca	93N/11W	Au, Ag, Zn, Pb, Cu	manto / skarn	14 ddh, 1103 m
Pine (Stealth Mining)	094E 016	Omineca	94E/2E	Au, Cu	porphyry	7 ddh, 1290 m
QR (Kinross Gold)	093A 016	Cariboo	93A/12W	Au	skarn	84 ddh, 6138 m
Tsacha (Corona Gold)	093F 055	Omineca	93F/3E	Au, Ag	epithermal vein	15 ddh, 5600 m

In 1998, drilling focused on the #1 vein zone and #3 oxide massive sulphide zone. The #1 zone has a minimum strike length of 450 metres. Drilling 240 metres north of the #1 zone portal yielded several encouraging assays including a 2.3-metre intersection in hole LD-98-14 that averaged 2.04 g/t Au, 838.1 g/t Ag and 2.26% combined Pb-Zn. A linear Pb-Zn-Au-Ag soil geochemical anomaly, that has not yet been drilled, extends northward an additional 1000 metres.

The #3 zone is approximately 850 metres northwest of the #1 zone portal. It is an oval-shaped, sulphide-rich body that is intensely oxidized at surface. A 'geologically inferred resource' of 570 000 tonnes grading 4.4 g/t Au and 43.6 g/t Ag has been determined from past drilling on this zone. In 1998, trenching of the zone provided three composite samples that were subjected to bottle-roll cyanide-solubility tests. Average gold recovery was 78.5%. The best assay from three holes drilled to test the south extension of the zone came from a 1.7-metre intersection in hole LD-98-6 which averaged 8.53 g/t Au, 42.99 g/t Ag and 5.45% combined Pb-Zn.

NATION LAKES AREA

Agau Resources Ltd. completed a modest trenching program on its **Eagle** claims immediately south of Tchentlo Lake. Copper-gold-silver vein and stockwork mineralization is associated with a shear zone, 1 kilometre wide, that cuts gabbroic rocks of the Hogem batholith.

North of Inzana Lake, Richard Haslinger Sr. staked the **Fran** claims to cover several high- grade gold veins hosted by rusty weathering andesite of the Triassic Takla Group. Grab samples from the quartz-sulphide veins assayed as high as 25.16 g/t Au, 31.2 g/t Ag and 5.59% Zn.

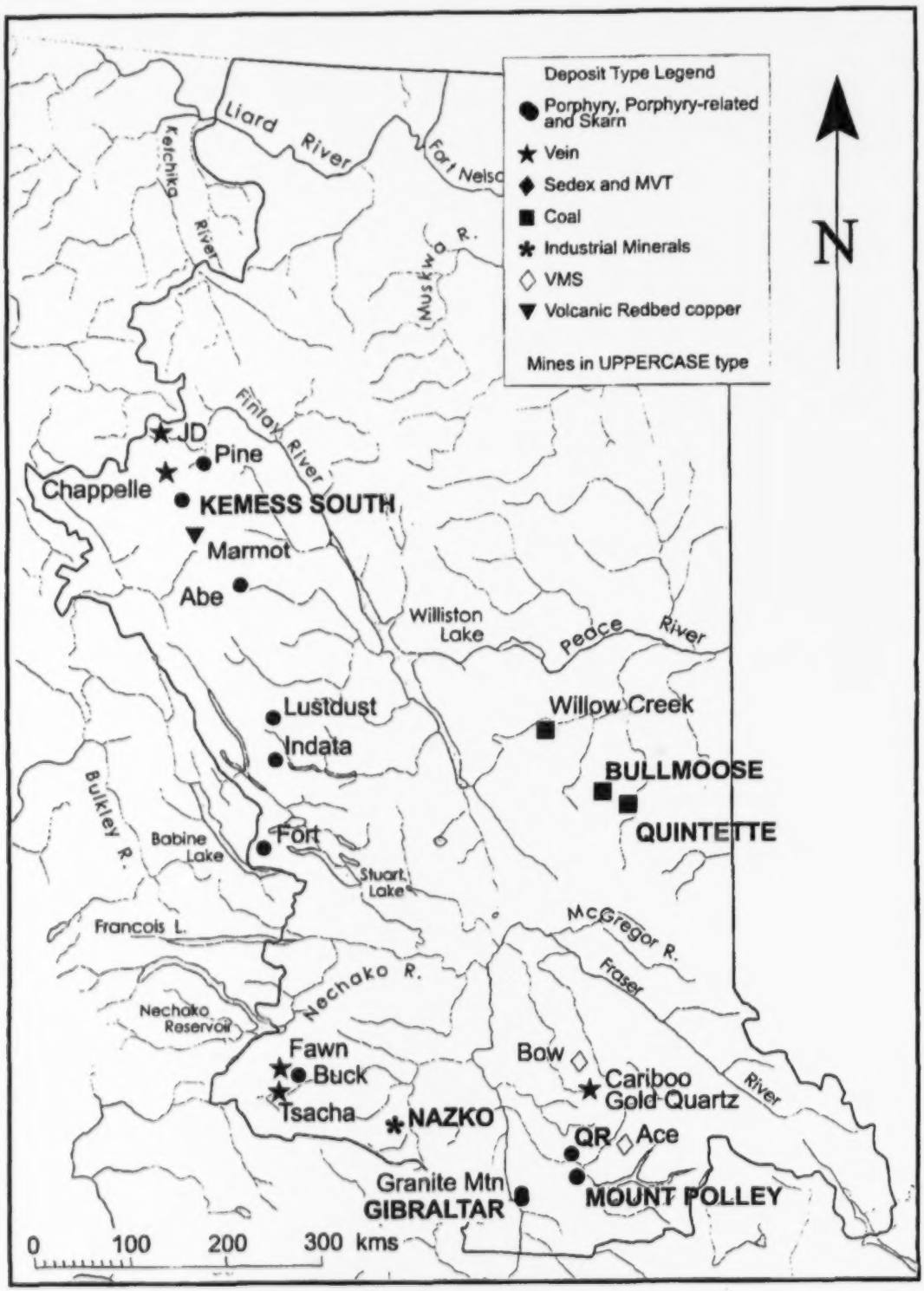

Figure 4. Operating mines and major exploration projects, Northeast-Central British Columbia.

BABINE LAKE AREA

Immediately west of Cunningham Lake, Ascot Resources Ltd. and joint venture partner Eastfield Resources Ltd. conducted a large mapping, geochemical sampling and IP program on the new **Fort** copper-molybdenum-silver prospect. The discovery was made by Elden Nyberg and prospecting partner Richard Haslinger Sr. during logging road construction late in 1997. The main Specularite Lake showing is a mineralized breccia exposed along several hundred metres of road cut. The breccia is comprised of angular clasts of diorite and chlorite schist that are cemented by translucent quartz and coarse-grained ankerite accompanied by coarse grains of chalcopyrite and pyrite. The breccia body is on the contact between a body of pyroxenite and Triassic Takla volcanic rocks to the west. It follows a trend of about 340°, is up to 200 metres wide and at least 500 metres long. Eight samples from the Specularite Lake showing averaged 0.34% Cu, 175 ppm Mo and 72.3 ppm Ag. Eastfield plans to drill the main showing area in 1999.

NECHAKO PLATEAU

The largest exploration program in the region took place on the **Tsacha** epithermal gold property located in the Naglico Hills area of the Nechako Plateau. Teck Exploration Ltd., as operator on behalf of joint venture partner Corona Gold Corporation, drilled a series of 500+ metre diamond-drill holes to test the continuity of the main Tommy vein beneath a gently dipping post-mineral microdiorite sill 120 metres thick,. The vein was intersected by several holes. Vein mineralization consists of crudely banded, sugary white to grey quartz with common red hematite stain and traces of fine-grained pyrite. True widths of the vein measured up to 5 metres. Assay results are pending.

Exploration drilling by Teck in 1994-1996 on the main Tommy vein above the sill, outlined a geological resource of 478 600 tonnes grading 8.7 g/t Au and 82 g/t Ag (using a 3 g/t Au cutoff). The potential for expansion of this resource below the sill is considered to be excellent. There are also several subordinate veins (*e.g.* the Larry vein) that have not yet been drilled in sufficient detail to be included in any reserve calculation.

On the adjacent **Blackwater** property (Taken 1 claim), Paramount Ventures & Finance Inc. conducted limited IP and trenching near previously identified north-trending silver-gold soil geochemical anomalies. Trenching uncovered 20 metres of rhyolite breccia containing traces of bornite and malachite.

Pacific Star Resources Ltd. funded the drilling of seven holes on the **Buck** property. The program focused on an area near the Rutt zone where altered and mineralized fine-grained sedimentary rocks are exposed. Drilling intersected hornfelsed and brittle-fractured tuffaceous siltstones that host fracture-controlled and, to a lesser extent, stratabound zinc±lead-copper-silver-gold mineralization. Sphalerite, galena, pyrite and chalcopyrite combine for up to 3% of the rock over narrow intervals.

At the **Fawn** property, Cascadia International Resources Ltd. completed five diamond-drill holes targeting the subsurface expression of the Malaput showing. Drill core displays pervasive quartz-sericite alteration of the intermediate volcanic host rocks, but assay results were not encouraging.

CARIBOO REGION

At Wells, International Wayside Gold Mines Ltd. continued to explore the **Cariboo Gold Quartz** mine, a former lode gold producer. A total of 24 underground percussion holes were drilled upwards from the 1200 level into the Sanders and Pinkerton zones. The best drill assays were from narrow, high-grade veins (*i.e.* 1.2 m grading 28.6 g/t Au in hole UP98-04) or broad stringer or replacement zones (*i.e.* 23.1 m grading 1.93 g/t Au in hole UP98-05). A revised 'geological mineral inventory' was released by the company in late January, 1999. At a 0.03 oz/ton (0.93 g/t) Au cutoff, the uncut measured, indicated and inferred categories total 7 437 500 tons (6.75 Mt) grading 0.135 oz/ton (4.20 g/t) Au.

Diamond drilling from surface tested the BC vein over a strike length of approximately 250 metres and to shallow depths of about 100 metres. Encouraging assay results over narrow intervals were received (e.g. 12.94 g/t Au over 6 metres in hole BC98-09). Historical records indicate that there are several high grade shoots contained within the vein. Drilling of the entire strike length of the BC vein over the next year or two is a priority for the company.

Harvey Creek Gold Placers Ltd. discovered several high-grade gold veins on the **Simlock Creek** property located 5 km north of Cariboo Lake. Trenching focused on soil anomalies as high as 4000 ppb Au and exposed several auriferous mesothermal quartz veins. The highest assay from chip sampling graded 78.51 g/t Au (2.29 oz/t), 274 g/t Ag (8 oz/t Ag) and 200 ppm Bi over 2 metres. An IP survey slated for the late fall was deferred until 1999.

The **Ace** volcanogenic massive sulphide/vein prospect, located 34 km northeast of Likely, was drilled late in 1998 by Barker Minerals Ltd.. Seven diamond-drill holes targeted the central portion of an 8-kilometre long, east-trending float train of gold-enriched volcanogenic massive sulphide (VMS) and quartz-sulphide vein material. Assay results from the drill program are not yet available. Trenches excavated in 1997 exposed both styles of mineralization. VMS-style mineralization consists of crudely banded sulphides, primarily pyrrhotite-pyrite with lesser chalcopyrite and

sphalerite, in chloritic quartz-feldspar schists. Quartz-sulphide veins contain variable amounts of pyrite, base metal sulphides, and sericite, biotite, chlorite and tourmaline.

Eureka Resources Inc. conducted grassroots exploration on its **Bow** volcanogenic massive sulphide prospect, located approximately 15 km north of Wells. Eureka optioned the Bow and Ron 1-4 claims late in 1997 from Martin Peter, who had identified two areas of highly anomalous copper±zinc±gold±silver VMS float. Massive fine-grained pyrite with faint bands of chalcopyrite comprise much of the anomalous sub-angular cobble to small boulder-size float. Assays of this material range from 1 - 7% Cu with up to 4 g/t Au, 7 g/t Ag and several hundred ppm As. Zinc grades are generally less than 1% and lead grades are negligible. The area is underlain predominantly by basalt, chert and argillite of the Mississippian-Permian Antler Formation (Slide Mountain Terrane). The setting is similar to that of the Chu Chua VMS deposit northeast of Barriere, which is hosted by Fennel Formation (Slide Mountain Terrane). In 1998, after staking additional claims, the company completed an airborne Mag-EM survey over its tenure that identified several prominent EM conductors. Follow-up ground-based EM and soil geochemical surveys helped to establish 3 priority targets that the company intends to drill in 1999.

Golden Kootenay Resources Inc. (with funding provided by Excellerated Resources Inc.) began a diamond drilling program to test several gravity anomalies on its **Grizzly Lake** zinc-lead property 65 kilometres northeast of Likely. Dolomitized and brittle-fractured limestone of the Hadrynian Isaac Formation hosts numerous mineralized stockwork and breccia zones within a 3-kilometre by 10-kilometre belt. The zones are comprised mainly of smithsonite and cerrusite with lesser sphalerite and galena.

Big Valley Resources Inc. conducted a soil geochemical sampling program on its **Hugger** 7 and 8 claims, immediately south and west of the QR mine. The survey identified several localized copper anomalies (>250 ppm Cu) and a broad gold anomaly (>30 ppb Au) in an area underlain by two small dioritic intrusions. No work was carried out on the Lloyd 2 claim, immediately north of the Mount Polley mine, where the company has outlined a 'measured and indicated resource' of 2.5 million tonnes grading 0.546% Cu and 0.391% Au.

The **Gerimi Creek** property, 25 kilometres southeast of Quesnel, was re-evaluated by Paramount Ventures & Finance for its potential to host epithermal gold mineralization. Assays up to about 5 g/t Au are associated with narrow quartz veins that exhibit comb and colloform textures.

On the United Gunn Resources conducted a broad grassroots exploration program on five properties that comprise its **Granite Mountain** porphyry copper-molybdenum project. The properties (Copper Ace, Copper King, Beedy Creek, Credge Creek and Sheridan) adjoin the Gibraltar mine to the west, north and east. Prospecting, mapping, soil and rock geochemical sampling and geophysical (IP) surveys took place on six different grids. Two new zones, the Bysouth showing and the Rick showing, were discovered and are located 8.5 km north and 1.5 km northwest of the mine, respectively. Grab samples of brecciated intrusion from the Bysouth showing contain disseminated and fracture-controlled chalcopyrite that assay up to 4.9% Cu. The showing occurs in a NW-trending fault that has been traced for about 1.6 km. The Rick showing is comprised of rocks similar to those that host the ore at Gibraltar. Chlorite-sericite schists contain disseminated and fracture-controlled chalcopyrite and sphalerite. The Rick showing is part of a 1200 x 800 metre copper soil anomaly. Follow-up diamond drilling has been proposed for 1999.

INDUSTRIAL MINERALS

West of Mackenzie, local entrepreneurs Hunter Humphries and Jim Bellevance quarried ten 10-tonne blocks of an attractive pale pink, coarse-grained Cretaceous granite from their **Aspen** claims, and submitted them to a plant in Washington for preliminary processing and test marketing.

Ava Resources Inc. did not proceed with development of its **Wishaw Lake** dimension stone quarry, located 160 kilometres east of Prince George in the Kakwa Recreation Area. However, a small amount of pink quartzite was submitted for structural quality testing and polishing characteristics. The deposit occurs in a valley immediately north of Wishaw Lake and is comprised of maroon to white-banded quartzite of the Lower Cambrian Mahto Formation.

The **Farm 1-21** mineral claims were staked by a numbered company to cover known phosphate occurrences east of Monkman Park (93I/10) in the Wapiti Lake area. Conflicts with a proposed protected area recommended by the Dawson Creek LRMP resulted in a suspension of planned exploration. The issue has not been resolved.

Exploration for dimension stone and other industrial mineral commodities, such as magnetite, silica, slate and talc, as well as semi-precious gemstones, such as jade, soapstone and other carving media, was conducted in several areas of the region.

OTHER INFORMATION

The Prospectors Assistance program awarded grants to support 6 grassroots exploration projects in the region.

Most of the projects focused on the search for auriferous vein, VMS or porphyry mineralization in the Cariboo.

The BC Geological Survey Branch released Regional Geochemical Survey (RGS) data for the Mesilinka River (94C) map area in July, and while there are some excellent multi-element anomalies in some very prospective terrain in both the northern Quesnel Trough and southern Gataga lead-zinc belt, there was little follow-up. Likewise, there was limited activity generated by new gold and neutron activation RGS data that was provided at the same time for the previously released Hazelton (93M) and Manson Creek (93N) map areas.

An airborne magnetic survey (approximately 33 300 line kilometers) conducted in 1997 by the GSC over part of the northern Omineca (NTS 94E and 94F/SW including part of the southern Gataga) was released late in January, 1998, and may stimulate exploration in that area next year.

LAND USE PLANNING

There are eleven planning districts within the Northeast-Central Region. Planning in the southern part of the region resulted in the completion of the regional level Cariboo-Chilcotin Land Use Plan in October 1994. Subregional level Land and Resource Management Planning (LRMP) has proceeded in the remaining eight planning districts. Four LRMPs, Vanderhoof, Fort Nelson, Fort St. John and Prince George, have been approved by government. Three others, Dawson Creek, Fort St. James and Robson Valley, are in government review and announcements are expected in 1999. The Mackenzie LRMP is nearing completion and a recommended plan will likely be forwarded to government review and consideration in late 1999.

OUTLOOK FOR 1999

Next year exploration activity in the region is expected to stay at or below the low level witnessed in 1998. There is little encouragement from forecast metal prices, although gold is expected to recover somewhat. This might translate into an increase in placer activity and stimulate exploration at several advanced precious metal projects. Some of this years grassroots discoveries may develop into major projects in the near future.

ACKNOWLEDGMENTS

This report is a compilation of information collected from property visits by the Regional Geologist and other Prince George Regional Operations staff, as well as from information provided by many mine and exploration geologists working throughout the region. The review of Land Use Planning was contributed by Jamie Pardy. Ed Beswick and Ken MacDonald are acknowledged for reviewing and improving this report.

SOUTHWESTERN REGION

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INTRODUCTION

The Mineral Development Office in Vancouver was opened in May, 1998. It provides information and client-oriented services to researchers, prospectors and others involved in exploration and mine development. During 1998, it also handled the Regional Geology function for Southwestern Region.

HIGHLIGHTS

- Boliden Westmin (Canada) Limited extended the Marshall zone, a precious metal enriched lens of volcanogenic massive sulphide at Myra Falls.
- Nucanolan Resources Limited drilled the Lara volcanogenic massive sulphide deposit, near Duncan.
- Lafarge Canada Inc. acquired the Gillies Bay limestone quarry on Texada Island.

EXPLORATION AND PRODUCTION TRENDS

The aggregate tonnage and value of mineral production in the region dropped in 1998, as the major mines produced less and commodity prices declined. Boliden Westmin (Canada) Limited temporarily ceased production at Myra Falls in December and started to rehabilitate some of the underground workings. Quinsam Coal Corporation also cut production. In July, it suspended overseas coal shipments and reduced staff. The aggregate value of industrial mineral and sand and gravel production in the region probably remained approximately the same as last year.

Exploration activity in the region decreased in 1998. There were fewer major projects (arbitrarily defined as those likely to have incurred costs in excess of $100 000) than in 1997, but the estimated aggregate expenditure, at $6.0 million, was similar to the previous year. The figure is, however, somewhat misleading as over $4.0 million was spent on one project, mine-site exploration at Myra Falls.

Table 1 lists, and Figure 1 shows the location of the mines, quarries and major exploration projects active in 1998. In addition to the mines and quarries, there were ten major exploration projects, down from fourteen in 1997, a total which included some hold-overs from 1996. They show continued interest in exploration for higher grade metallic deposits, such as volcanogenic massive sulphide deposits (*e.g.* Myra Falls, Lara, Thumb Peak), gold veins (*e.g.* Privateer, Snow, Mactush, Valentine Mountain) and copper-gold skarn deposits (*e.g.* Yreka). They also show ongoing interest in industrial minerals, particularly limestone (*e.g.* Gillies Bay, Slesse, Varney Bay). There was very little exploration for lower grade, porphyry deposits.

In 1998, most of the major projects were on Vancouver Island. There were only two, (Thumb Peak and Slesse) on the Mainland but there were several more modest programs indicating at least some interest in the volcanogenic massive sulphide (*e.g.* Britannia, Ecstall) and high-grade vein (*e.g.* Surf Inlet, Doratha Morton) potential of the Coast Plutonic Complex.

There were several prospecting programs in the region in 1998 and several new mineral occurrences were found; most notably, a possible volcanogenic massive sulphide showing in a pendant north of Sechelt.

There was no exploration for coal on Vancouver Island this year. Quinsam Coal Corporation concentrated on production at the Quinsam coal mine and deferred further work on its T'Sable River coal property, near Courtenay, until market conditions improve.

Economic growth and development in the Pacific Northwest over the past few years has led to increased demand for industrial minerals. This is particularly noticeable in Southwestern Region where there are several new limestone and crushed rock "aggregate" quarries either planned or currently under development. The total tonnage of limestone and aggregate produced and shipped (both locally and also into the United States) remains high despite the recent down-turn in economic conditions. The dimension stone market has also grown and remains fairly strong, although local producers are susceptible to competition from abroad.

PRODUCING MINES AND QUARRIES

The producing mines and quarries in the region struggled to remain competitive in 1998. Most suffered from reduced commodity prices but exporters at least reaped some benefit from the decline in value of the Canadian dollar. Some of the larger operations changed ownership and made substantial changes to their operational plans. As a result, they should be better placed to compete in the years ahead.

MYRA FALLS OPERATION

In January, 1998, Boliden Limited completed its acquisition of Westmin Resources Limited and Boliden Westmin (Canada) Limited assumed control of the Myra Falls operation, near Campbell River. The company mines a large and geologically complex volcanogenic massive sulphide deposit in Sicker Group volcanic rocks at the south end of Buttle Lake. The operation has a nominal mill capacity of 3850 tonnes per day and a staff of approximately 450 people.

In 1998, the company mined 1 046 835 tonnes of ore grading 1.7% Cu, 5.57% Zn, 0.17% Pb, 1.63 g/t Au and 22.91 g/t Ag and reported production of 16 610.6 tonnes of copper, 54 312.2 tonnes of zinc, 671 777 grams of gold and 15 608 555 grams of silver. Production was down from last year as difficult ground conditions in the Battle and Gap zones led to excessive dilution and lower productivity.

In December, Boliden Westmin temporarily suspended production and redirected the resources of the mine to plant maintenance and the rehabilitation of underground workings, including the main access ramp to the Battle and Gap zones. It will keep the mill running during the shut down, albeit at reduced capacity, processing waste to be used as back fill to stabilize some of the open stopes. It will also continue with development work and with its on-going exploration program. It should resume production in April, 1999.

As of January, 1999, Myra Falls had a fully diluted mining reserve of 6 785 800 tonnes grading 7.9% Zn, 1.5% Cu, 0.5% Pb, 1.5 g/t Au and 36.8 g/t Ag, sufficient for approximately six years of production. However, the mining reserve understates the true potential of the operation as it also has a large, less well defined, geological resource and considerable geological potential. The company is committed to exploration. In 1998, it spent $4.2 million on the property, the largest expenditure on any one project in the province. Much of it went into providing access and drilling the northwestern extension of the Marshall zone, a high-grade sulphide lens that was identified in 1993.

The company completed a 750-metre crosscut on the 10 level in the Lynx mine and used it to establish drill stations to test for the extension. While driving the crosscut, it used it to drill a series of angled holes ahead of the development. In May, one of these cut a substantial thickness of barite and sulphide in rhyolite breccia, at approximately the same stratigraphic level as the Marshall zone but 500 metres to the northwest. It assayed 5.6 g/t Au, 184.5 g/t Ag, 0.3% Cu, 0.5% Pb, 5.1% Zn and 23.4% Ba over 21.0 metres. The next four holes cut the horizon but returned no significant mineralized intercepts. However, the sixth encountered similar material approximately half way between the earlier drill intercept and the original discovery holes. It assayed 3.9 g/t Au, 284.6 g/t Ag, 1.5% Cu, 2.3% Pb, 12.2% Zn and 22.6% Ba over 20.7 metres. In this second intercept, semimassive barite overlies zinc and precious metal rich massive sulphide. The company completed the crosscut in September and started to search for the zone with shorter and steeper holes from nearer its face. One returned a similar, shorter but higher grade intercept. It returned 8.4 g/t Au, 220.6 g/t Ag, 2.0% Cu, 1.4% Pb, 33.5% Zn and 7.6% Ba over 8.7 metres.

The company is encouraged by the results which show excellent potential for a significant tonnage of ore similar to that found in the Gap deposit. The mineralization is in quartz-sericite- altered rhyolite breccia in the lower part of the H-W horizon, close to the footwall andesite. The new intercepts contain some of the highest gold and silver values so far found on the property. The Marshall zone is approximately 700 metres below the 10-level drift and it will require careful drilling to establish its width, continuity and tonnage. The company plans to continue drilling the deposit over the coming year.

The company also finished a drilling program started in the Ridge zone area, west of the Battle deposit, in 1997. The results indicate wide zones of low-grade disseminated and stringer sulphide as well as narrower zones of higher grade clastic sulphide that are not laterally continuous. In addition, it began a deep drilling program to test for undiscovered sulphide horizons and stringer sulphide zones in and below the footwall andesite. The program will continue in 1999.

Boliden Westmin carried out a limited amount of surface exploration work, including a deep- searching electromagnetic survey over Phillips Ridge to locate targets for drilling. It also completed six diamond-drill holes, for an aggregate depth of 5945 metres, from Myra Ridge and from the old construction campsite in Myra Creek valley. The holes tested for extensions of the Trumpeter West zone located last year. They intersected the expected lithologies and some also returned clastic-style mineralization, but there were no ore-grade intercepts.

QUINSAM COAL MINE

In April, Balaclava Enterprises Limited gained control of Hillsborough Resources Limited which, in turn, controls Quinsam Coal Corporation. The latter operates a relatively small scale underground coal mine near Campbell River. The operation has a resource of approximately 44 million tonnes and a nominal annual production capacity of 1.2 million tonnes of clean, high-quality bituminous thermal coal. The Company has increased production over the past few years but it has yet to operate at capacity. It produced approximately 1.0 million tonnes in 1997. It had planned to increase this to 1.2 million tonnes in 1998, however it encountered stability problems underground and also faced deteriorating economic conditions in Asia, its principal

off-shore market. In July, it cut both staff and production. It reduced the on-site work force from approximately 200 to 80, adjusted production to match the needs of the local market in the Pacific Northwest, and substantially reduced shipments to off-shore customers. The economic situation improved slightly in the fall and the company was able to recall 21 of its employees. The changes instituted at the mine have reportedly improved productivity from approximately 2.5 to 4.1 tonnes of clean coal per man hour. By year's end, the mine had produced 702 450 tonnes of clean coal, of which approximately 88% had come from the 2N production block. The remainder came from 4S area.

There was no exploration drilling at Quinsam this year, although a program had been proposed. In view of the economic conditions, it was deferred to 1999. Instead, the company focused on a major review of its mine plan. One option is to revert to its former method of operation, which combined open-pit and underground mining.

Hillsborough Resources Limited has a controlling interest in T'Sable River Coal Corporation, which has reported indicated and inferred reserves of 39 million tonnes of high-volatile metallurgical or coking coal in the T'Sable River area, south of Courtenay. The company has permits in place and plans to extract a bulk sample when economic conditions improve.

LIMESTONE QUARRIES

In October, Lafarge Canada Inc. acquired Holnam West Materials Limited and, through it, control of the quarry at Gillies Bay that will produce limestone for its newly upgraded cement plant in Richmond. The quarry is now owned by an affiliate, Texada Quarrying Limited.

Texada Quarrying, and its neighbour on the island, Ash Grove Cement Company, are the largest suppliers of limestone in the Pacific Northwest. Between them, they ship approximately 5 million tonnes of chemical, cement, agricultural and crushed rock (aggregate) grade limestone annually to customers throughout the Lower Mainland and northwestern United States. Limestone consumption as a whole has been stable over the past few years. However, demand for cement-grade limestone is expected to increase with the opening of Lafarge Canada's upgraded plant, in the second quarter of 1999. The plant will produce approximately 1.0 million tonnes of cement annually, double that of its predecessor. Construction aggregate sales are tied to major infrastructure developments and tonnages vary considerably from year to year. Demand dropped in the local market in 1998, but increased in the United States. Both suppliers expect aggregate sales to remain at current levels in the short term and increase in the long term. Ash Grove Cement plans to build a wash plant for handling aggregate.

Following its acquisition of the Gillies Bay operation from Holnam West, Texada Quarrying drilled 25 core holes, for a total depth of 1830 metres, to confirm the distribution of different grades of limestone around and below the existing pit.

Tilbury Cement Limited, the other major cement producer in the Lower Mainland, currently purchases limestone for its plant in Delta from existing suppliers on Texada Island. However, it is considering opening its own quarry. Through a subsidiary, Lehigh Portland Cement Limited, Tilbury owns a past-producing quarry at Grilse Point, near Blubber Bay and a substantial ground position over suitable limestone near Davie Bay on the west side of the island. In 1998, it drilled six core holes, for an aggregate depth of 200 metres, in the vicinity of its existing pit and started a major exploration program at Davie Bay. The Davie Bay property has been explored in the past; C.B.R. Cement Canada Limited briefly considered putting it into production in the early 1990s.

Imperial Limestone Corporation is a third limestone producer on Texada Island. It produces approximately 220 000 tonnes of chemical grade limestone annually. Most of it is shipped to Seattle to be used as industrial fillers. IMASCO Minerals Inc. owns a similar, but smaller, quarry at Benson Lake on Vancouver Island. It produces approximately 40 000 tonnes of bright, white limestone annually for fillers and other specialty uses.

I. G. Machine and Fibre Limited opened a new limestone quarry in the region in 1998. In the spring, it diamond-drilled three exploratory holes, for an aggregate depth of 368 metres, to test for continuity and depth of limestone adjacent to an existing Ministry of Highways quarry near the mouth of Slesse Creek in the Chilliwack valley. The company then extracted and tested a 10 000-tonne bulk sample from the government quarry and applied for permits for its own development. In the fall, it cleared the ground and quarried an additional 24 000 tonnes. It will be used as a filler at the company's new asphalt shingle plant at Sumas, in Washington State. The company expects to produce approximately 60 000 tonnes of limestone for the plant in 1999. When the shingle plant is fully operational, production may increase to approximately 240 000 tonnes per year.

Chilliwack Limestone Inc. opened a small limestone quarry in the Chilliwack River valley in 1998. It permitted a site near the confluence of the Chilliwack River and Nesakwatch Creek for extraction of a 10 000-tonne bulk sample and shipped approximately 4 000 tonnes for rip-rap and other purposes.

OTHER INDUSTRIAL MINERALS

In 1995, Monteith Bay Resources Limited received a certificate to produce "geyserite" silica from a seasonal

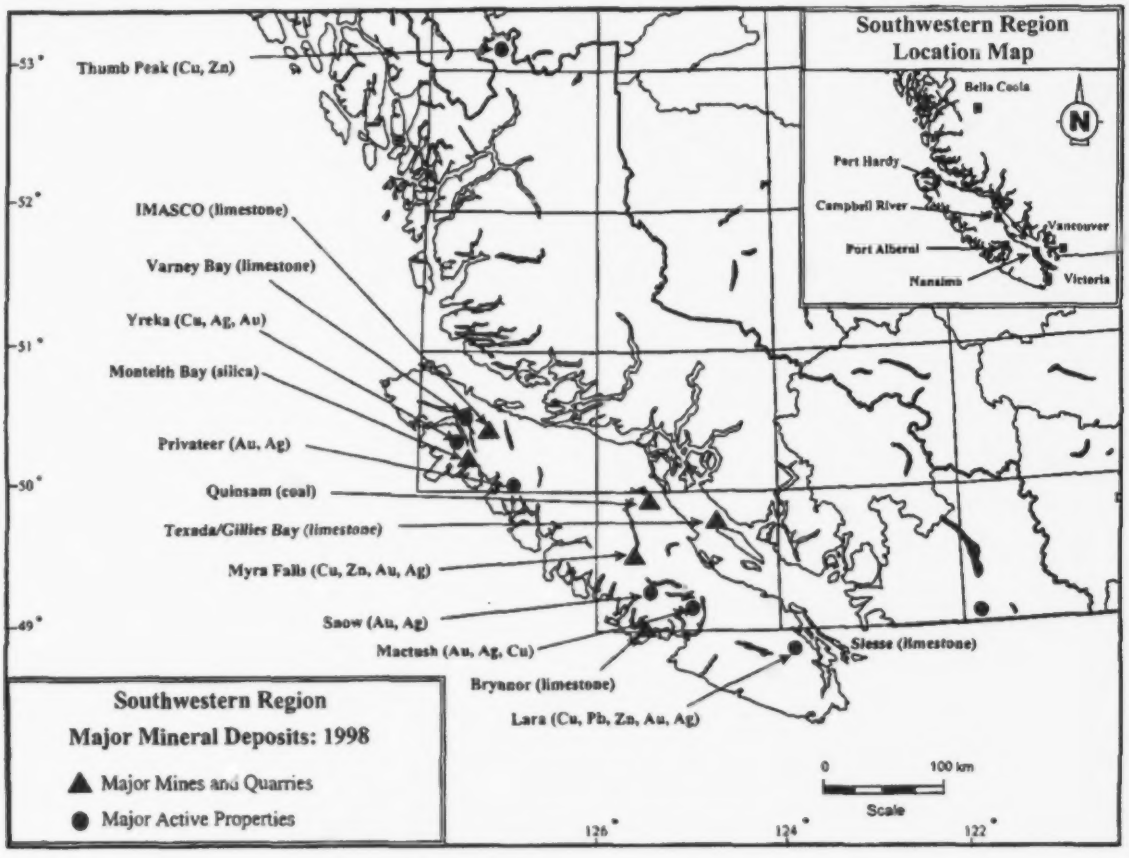

Figure 1. Major mineral deposits, Southwestern Region, 1998.

quarry on Easy Inlet, at the north end of Vancouver Island. The quarry is permitted to produce up to 100 000 tonnes per year but it is not yet in production. In 1998, Tilbury Cement Limited bought the property and prepared it for production. It expects to make its first shipment of approximately 30 000 tonnes in 1999.

New Global Resources Limited also has an interest in the area. It has applied for permits to extract a 10 000-tonne sample of creamy white, compact, soapy pyrophyllite from an old quarry a few hundred metres south of the Monteith Bay silica deposit. The two mineral occurrences are part of an extensive high-level quartz-alunite alteration zone formed by fluids associated with andesite dikes cutting Bonanza Group volcanic rocks.

Elsewhere on Vancouver Island, J.J.M. Construction Limited extracted 245 000 tonnes of rock aggregate from the waste dumps at the past-producing Brynnor magnetite mine near Kennedy Lake. The material, composed of recrystallized limestone with a minor amount of epidote, garnet and magnetite-bearing skarn, is being used in the construction of a coastal breakwater near Aberdeen, in Washington State. The company shipped coarse (> 0.15 m) and fine fractions by barge from a forestry load-out facility at Toquart Bay.

On the mainland, Great Pacific Pumice Inc. extracted between 7000 and 8000 cubic metres of pumice from its seasonal quarry on the Lillooet River north of Pemberton. The demand for pumice is strong and the company hopes to increase production once it has established a permanent processing plant. Currently, most of its product goes to horticultural suppliers, but there is considerable potential for pumice as a light weight aggregate filler in the construction industry.

Clayburn Industries Limited produces approximately 25 000 tonnes of fireclay annually from a series of pits on Sumas Mountain. Some is used to manufacture specialty refractory products that are sold world-wide. The remainder is used in the production of face bricks. With a partner, Clayburn also supplies shale for local cement plants.

On Texada Island, Consolidated Van Anda Gold Limited completed construction of a small mill capable of

TABLE I. MAJOR EXPLORATION PROJECTS, SOUTHWESTERN REGION, 1998

Property (Owner)	MINFILE	Mining Division	NTS	Commodity	Deposit Type	Work Done
Gillies Bay quarry (Texada Quarrying Ltd.)	092F 395	Nanaimo	092F/10E	Limestone		25 ddh, 1830 m
Lara (Nucanolan Resources Ltd.)	092B 129	Victoria	092B/13W	Cu,Pb,Zn, Ag,Au	Massive suphide	12 ddh, 2550 m
Mactush (SYMC Resources Ltd.)	092F 012 092F 103	Alberni	92F/2W	Au,Ag,Cu	Vein	trenching
Myra Falls (Boliden Westmin (Canada) Ltd.)	092F 330 092F 073	Alberni	92F/12E	Cu,Zn,Au, Ag	Massive sulphide	u/g development 6 ddh, 5945 m 19 u/g ddh, 12 604 m
Privateer (Newmex Minerals Ltd.)	092L 008	Alberni	92L/2W	Au,Ag	Vein	bulk sample
Slesse (I.G. Machine and Fibres Ltd.)	092HSW 088	New West.	92H/4E	Limestone		3 ddh, 368 m bulk sample
Snow (Snowfield Resources Ltd.)	092F 336	Alberni	092F/6W	Au,Ag	Vein	10 ddh, 934 m
Thumb Peak (Sand River Resources Ltd.)	093E 117 093E 118	Skeena	093E/3E	Cu,Zn	Massive sulphide	5 ddh, 790 m
Tilbury quarry (Lehigh Portland Cement Ltd.)	092F 471	Nanaimo	092F/15E	Limestone		6 ddh, 200 m
Valentine Mountain (Beau Pre Explorations Ltd.)	092B 108	Victoria	092B/12W	Au	Vein	1 ddh, 306 m
Varney Bay (Ecowaste Management Ltd.)	092L 344	Nanaimo	092L/12E	Limestone		road building
Yreka (Tall Tree Resources Ltd.)	092L 052	Nanaimo	092L/5E	Cu,Ag,Au	Skarn	geochemistry, geology

producing clean magnetite from skarn ore stockpiled by Texada Iron Mines in the 1960s. The ore comes from the past-producing Paxton pit. In 1998, Consolidated Van Anda shipped a small amount of magnetite on a back-haul to the Quinsam Coal operation.

Dimension stone exploration and development was a major highlight in the region in 1997 and it remained an important exploration interest in 1998. Quarry Pacific Industries Limited, an affiliate of Margranite Industries, a local granite tile manufacturer, produced approximately 1000 tonnes of "granite" dimension stone from three sites in the southern part of the province, including two in the region. It took some talus blocks from a recently leased site in the Skagit valley, south of Hope and it extracted blocks from a quarry in the Anderson River valley, east of Spuzzum. Other dimension stone producers in the region include Matrix Marble Limited and Tsitika Stone Industries Limited, on Vancouver Island and Garibaldi Granite Group and Granite Island Quarries Limited on the Lower Mainland.

Garibaldi Granite Group recently opened a rock-processing plant in Squamish. It produces split-faced cut blocks and other specialty products for the construction industry. Its principal sources include nearby quarries in Squamish and along the Ashlu River, north of the town.

EXPLORATION ACTIVITY

VANCOUVER & INSHORE ISLANDS

YREKA

In 1988, Tall Tree Resources Limited explored the past-producing Yreka copper property, west of Neroutsos Inlet. The property covers numerous high-grade copper skarn showings that were discovered in the late 1890s and were explored intermittently prior to the second world war. The Yreka deposit was explored by Noranda Exploration Limited in the 1950s and it was put into production by Yreka Mines Limited and Mitsubishi Metal Mining Company Limited in the late 1960s. It produced approximately 137 000 tonnes grading 2.87% Cu, 33.1 g/t Ag and 0.36 g/t Au between 1965 and 1967.

The mineralization at Yreka occurs in epidote, garnet and sulphide-bearing skarn in an altered agglomerate and tuff unit that is interbedded with recrystallized limestone near the base of the Bonanza Group. The ore appears to occur in lenses that are both structurally and stratigraphically controlled. Most are in areas of increased, fault induced, porosity and dike intrusion near the axis of a northwesterly plunging fold on the east side of a small diorite stock.

The property was last explored in the late 1970s. This year, Tall Tree Resources Limited reestablished the road system, re-examined the old workings and mapped and prospected the area. It focused much of its attention to the west of, and down slope from, the known showings. It located several new target areas.

PRIVATEER

The Privateer mine, at Zeballos, is another past-producer that received attention in 1998. Newmex Minerals Limited reopened the 1100-level portal, mined a 160-tonne sample of high-grade vein material and shipped it to the Roberts mill at Greenwood for custom processing. The company has permits to extract another 740 tonnes which it will probably process on site. It plans to refurbish an existing 50 tonne per day mill and gravity circuit that New Pioneer Mines Limited built in 1989. It has already upgraded the existing tailings dam to accept the remaining permitted tonnage.

The Privateer mine is the largest gold producer in the Zeballos mining camp. It saw peak production between 1937 and 1948 and produced 282 300 tonnes of ore containing 5501 kilograms of gold, 2160 kilograms of silver, 4063 kilograms of copper and 10 093 kilograms of lead prior to 1982. New Privateer reopened the mine in the early 1980s and rehabilitated some of the workings. It shipped a small tonnage of high-grade vein material for processing off-site and later built the current mill which had a short active life. It is reported to have processed approximately 2000 tonnes of relatively low-grade ore prior to its closure in 1991.

The Privateer deposit comprises numerous narrow (0.1 to 0.3 m wide), tight, sulphide-bearing quartz veins in steeply dipping, northeasterly trending shear zones that cut the northwestern contact of the Tertiary Zeballos stock. The veins cut quartz diorite and calcsilicate skarn and show a strong spatial association with a set of late dikes. Most of the production came from three of the veins. They are composed of banded, locally vuggy, white quartz with variable amounts of pyrite, sphalerite, galena, chalcopyrite, arsenopyrite and free gold. Gold values generally increase with increased sulphide content, although there is relatively little gold tied up in the sulphide. Old records suggest that approximately 85% is recoverable by gravity separation. Newmex Minerals is currently mining a narrow vein located close to the 1100-level portal.

SNOW

There was no work on the Tay property, near Port Alberni, this year but Snowfields Resources Limited drilled ten core holes for an aggregate depth of 934 metres on the Snow property, 10 kilometres to the west. The company was exploring for similar gold-bearing quartz-carbonate veins to those drilled for on the Tay property last year. The veins share a common structural setting; both follow structures that splay off the Taylor River fault.

The holes tested for the down-slope strike extension of the "discovery vein", located in 1986 and for additional veins underlying soil geochemical anomalies identified as a result of later grid programs. The discovery vein is similar to the Privateer vein. It is a narrow (0.5 to 1.0 m wide), tight, sulphide-bearing quartz vein located in a steeply dipping, north to northwesterly trending shear zone that follows the contact between Karmutsen Formation volcanic rocks and granodiorite of the Island Plutonic Suite. It is multiphase, banded and locally vuggy. The vein contains a variable, but locally large, amount of sulphide, principally pyrite, pyrrhotite, galena and sphalerite. It also contains free gold, which introduces a nugget effect. Snowfields Resources screened its samples for metallics and reported numerous intercepts with erratic assays. Some of the better intercepts encountered include 14.4 g/t Au over 0.15 metre and 9.6 g/t Au over 0.7 metre.

The extension drilling was largely unsuccessful as the discovery vein is segmented by steeply dipping, northeasterly trending cross-faults that introduce a unknown amount of lateral off-set. The drill holes did not make adequate allowance for the off-set and they failed to locate the main vein. However, several cut narrower veins containing small amounts of gold. One hole, collared to

test a gold soil geochemical anomaly a considerable distance down-slope from the main showing, intersected several narrow, mineralized quartz veins.

MACTUSH

SYMC Resources Limited has a large land holding on the west side of Alberni Inlet, south of Port Alberni. The property covers several copper-gold and copper-gold-silver occurrences; some of which, like the Fred and Dave veins on Mactush Creek and the Mick (Kola) shear zone, are reasonably well described. Other showings are less well documented. There are numerous indications of porphyry copper-molybdenum, skarn copper-gold, shear-hosted copper-silver-gold and quartz vein hosted gold-silver-copper mineralization scattered on the property and in the surrounding area. In 1998, the company explored the two main structural targets and examined several other showings.

At Mactush, SYMC Resources focused its attention on the Fred and Dave veins and extended both through trenching. The veins are easterly to northeasterly trending, steeply dipping zones of crudely banded, vuggy quartz in shears that cut discordantly across a contact between Karmutsen volcanic rock and an Island intrusion. Both contain a minor amount of fine pyrite, pyrrhotite, chalcopyrite and traces of bornite and tetrahedrite. They appear to be laterally persistent and relatively uniform in grade. The Fred vein has a minimum length of 600 metres and is reported to have an average grade of 13.7 g/t Au, 60.0 g/t Ag and 0.9% Cu over minimum surface width of 1.5 metres. The Dave vein is similar. It has been traced for 365 metres and is reported to have an estimated, grade of 12.0 g/t Au, 47.0 g/t Ag and 0.6% Cu over an average surface width of 1.5 metres. Both of the veins are open along strike and relatively untested at depth.

The company also trenched the Mick (Kola) showing on Cous Creek, where Amstar Venture Corporation drilled a copper-bearing mineralized shear zone in 1986. The zone cuts Karmutsen volcanic rocks. It comprises a broad zone of strongly silicified and weakly carbonatized andesite containing discontinuous pods and lenses of pyrite and chalcopyrite and also zones of stringer and disseminated sulphides. SYMC Resources hopes to extend the known mineralization to depth and along strike. In 1998, it ran a magnetometer survey and trenched a section of the shear zone.

The Mactush property also covers the Dauntless mine, a small past-producing copper deposit close to the shoreline west of Alberni Inlet. SYMC Resources relocated the main adit and sampled high grade copper-silver-rich mineralization stockpiled at its portal. The material evidently comes from a tight but well mineralized shear zone that cuts Karmutsen volcanic rocks.

LARA

Further south, Nucanolan Resources Limited explored the Lara property, west of Duncan, for extensions to the Coronation zone volcanogenic massive sulphide deposit, which was last explored by Minnova Limited in the 1980s. The Coronation zone is approximately 10 kilometres northwest of Mount Sicker, where the Leonora, Tyee and Richard III mines saw limited production in the early 1900s and the Twin J mine operated in the 1940s.

The Lara property covers a large area of deformed, Sicker Group intermediate and felsic volcanic rocks in the hangingwall of a major, northeasterly dipping, reverse fault. According to Nucanolan, regional mapping suggests that the mineralized rocks may be overturned and lie on the south side of a major northwesterly plunging antiform. There are three main zones of massive sulphide mineralization on the property, the Coronation, Coronation Extension and Hanging Wall zones. There are also numerous lesser zones, small showings, geochemical anomalies and geophysical targets that, despite the locally extensive cover, trace the mineralized stratigraphy back towards Mount Sicker. The same rocks may occur near the Randy North zone, on the north side of the postulated antiform.

The Coronation zone has a reported drill-indicated resource of approximately 530 000 tonnes grading 1.01% Cu, 1.22% Pb, 5.87% Zn, 100.09 g/t Ag and 4.73 g/t Au. It is composed of massive, banded, laminated and stringer sulphides intercalated with fine tuff and sediment. The zone has been traced for a strike length of over 2000 metres and down dip for a depth of 440 metres. The precious metal content of the zone appears to be particularly high in the central core.

Nucanolan carried out orientation mapping and geochemical and geophysical programs in the spring, and a diamond drilling program in the fall. It recognized that the rocks are cut by numerous, northerly trending, faults that progressively offset the prospective stratigraphy to the north as one moves to the east. The company estimated and allowed for the off-set on these faults and drilled 12 core holes for an aggregate depth of approximately 2550 metres, looking for down-dip and down-plunge extensions of the Coronation Extension and neighbouring 262 zones. It tested a strike length of approximately 3 kilometres, from the Coronation zone portal to Silver Creek and beyond. The fifth hole intersected sphalerite, chalcopyrite, pyrite and pyrrhotite interbedded with tuff over a 4.5 metre interval. The intercept graded 3.86% Zn, 0.5% Cu and 1.01 g/t Au. The seventh hole also gave some encouragement, grading 0.54% Cu over 0.84 metre.

VARNEY BAY

Ecowaste Management Limited, an affiliate of Continental Lime Limited, carried out a modest work program on its chemical limestone deposit at Varney Bay on the south side of Holberg Inlet. It built roads, prepared drill sites and undertook social and environmental baseline studies in advance of a major drilling program that may start in 1999. The company hopes to permit a quarry large enough to supply its lime plant, in Tacoma, Washington, with up to 200 000 tonnes of limestone annually.

VALENTINE MOUNTAIN

Beau Pre Exploration Limited has been exploring for gold in the Leech River schists north of Sooke since the late 1960s, when the Discovery zone veins were located on Valentine Mountain. Over the years, the company and its partners have done a considerable amount of work both delineating the tonnage and grade characteristics of the known veins and locating additional exploration targets. Beau Pre has identified a broadly linear zone of gold showings, alteration zones and geophysical and geochemical anomalies that extends from Valentine Creek in the east to the Braiteach area west of the Jordan River, a distance of approximately 7 kilometres. The zone appears to define a structural break that is discordant to the stratigraphy of the underlying metasediments. It is marked by several generations of narrow, free gold bearing quartz veins in metasedimentary rocks and by broad (100 m wide) zones of quartz veinlet development, relatively weak alteration and low-grade mineralization. The latter are found in biotite schist derived from argillaceous and arenaceous sedimentary rocks, and in "amphibolite" derived from more reactive, tuffaceous sediment. The company believes that the gold mineralization is mesothermal and that late felsic intrusions and cross structures may have played an important role in determining its distribution.

In 1998, the company compiled previous work and, late in the year, started drilling some of the better targets. These include several of the broad but poorly defined alteration zones that are known to be enriched in gold and arsenic. The company is looking for a bulk-mineable deposit. In December, it diamond drilled a single hole in the vicinity of the Discovery zone to a depth of 306 metres. The hole was angled to intercept the D zone quartz vein system as well as other known veins and a broad altered, veinlet stockwork zone in the footwall of the main vein system. It intersected the various targets, more or less as projected. The company plans to continue with the program, drilling in the Jordan River area, in 1999.

OTHER PROJECTS

In addition to the major projects described above, numerous smaller programs were completed on Vancouver Island. Consolidated Logan Mines Limited conducted an induced polarization geophysical survey over a soil geochemical anomaly at Mount Redford, near Kennedy Lake. The anomaly appears to be related to a gold-bearing arsenopyrite stockwork in fractured granodiorite. Doublestar Resources Limited staked old showings near Nimpkish Lake and explored a new discovery of copper-rich skarn float on Storey Creek. It conducted ground geophysical surveys and identified numerous targets that have still to be tested. The same company also acquired the Fandora gold-vein property, near Tofino. This has an existing reserve and a considerable amount of development already completed. Doublestar plans to extract a 500-kilogram sample for metallurgical test work next spring.

SYMC Resources Limited was active on several properties in addition to Mactush. It prospected the NLD claims, near Port Alberni, for gold-bearing quartz veins and also for molybdenum. It also prospected its Kennedy River property for additional gold-bearing quartz veins. Inspiration Mining Corporation carried out a modest prospecting program on the Jasper property, near Cowichan Lake, following up on previous work on a volcanogenic massive sulphide target. In the process, it located a new, possibly volcanogenic, high-grade sulphide showing.

Several prospectors took advantage of the ministry's Prospectors Assistance Program and there were some notable successes. Richard Strong located angular blocks of copper-rich massive sulphide float in the bed of a forestry road near Jordan River. The source of the float is still unknown. Ron Walton discovered a new rhodonite occurrence in the Cowichan Lake area and John Telegus had some success delineating a soil geochemical anomaly associated with a quartz vein stockwork.

SOUTHERN COAST

There were only two major projects on the Mainland this year, a diamond drilling program at Thumb Peak and the previously described industrial mineral project at Slesse Creek. Other projects proposed for this year, such as drilling programs at Thunderbird (Nifty/Keen), near Bella Coola, Harrison Gold, near Harrison Lake and the extraction of a large bulk sample at Giant Copper, near Hope were deferred.

In the fall, the British Columbia Court of Appeal considered a Supreme Court decision regarding the ownership of the O.K. porphyry copper deposit near Powell River and subsequently confirmed CanQuest Resource Corporation's right to the property.

THUMB PEAK/SMABY

Sand River Resources Limited drilled five core drill holes, for an aggregate depth of 790 metres, exploring for volcanogenic massive sulphide deposits on the Thumb Peak property, in the extreme northeastern corner of the region.

The Thumb Peak or Smaby property covers a roof pendant on the east side of the Coast Plutonic Complex. The pendant is largely composed of mafic and felsic volcanic and coarse volcaniclastic rocks. However, it locally includes an appreciable amount of intermediate tuff and hosts several mineral showings, some of which may be volcanogenic in origin. The original showings were found as a result of regional stream sediment surveys carried out by U. S. Borax in the 1980s. Noranda Exploration Limited later mapped the pendant, flew an airborne geophysical survey and carried out a variety of geochemical and ground geophysical surveys. However, the company never drilled the property. Nine showings have been located on the property so far. Most are within a pronounced silica-sericite alteration zone, 2.0 kilometres long, within a felsic volcaniclastic unit. They include the Dick and Discovery showings. The former is a narrow band of massive magnetite, pyrite and minor chalcopyrite, and the latter is a composite zone of narrow, less than 50 centimetre, bands of semimassive to massive sphalerite, magnetite and pyrite in a chlorite and epidote-bearing altered andesite tuff.

In 1998, Sand River Resources drilled the Dick (Cu), Discovery (Zn), Prospector (Zn), Main and Ridge (Cu, Ag, Au) showings. The results were inconclusive. There is little sign of footwall alteration in the vicinity of the Discovery and Prospector showings and the company now feels that the mineralization may be vein or skarn-related. The Ridge zone produced an intercept assaying 7.52% Cu, 172 g/t Ag and 4.46 g/t Au over 0.35 metre but it too appears to be part of a later quartz-vein system. Geologically, the Dick showing is reported to be most attractive massive sulphide target. However, the hole drilled to test the showing failed to intersect the targeted volcanic horizon so its potential remains uncertain.

OTHER ACTIVITY

There were only modest exploration programs in the Loughborough Inlet gold camp this year. Thurlow Resources Limited prospected the DM property, near the Dorotha Morton mine, and explored to the north of the old Commonwealth adit, at the north end of the mineralized shear zone. It also collected soils in the vicinity of Picton Point where it has identified several en echelon gold-bearing quartz veins and molybdenite-bearing breccia zones.

Elsewhere, Wildrose Resources Limited prospected and sampled the Thunderbird (Nifty/Keen) property looking for evidence of Eskay Creek style mineralization associated with a known silver-barite horizon in volcanic rocks north of Bella Coola. Further south, Stirrup Creek Gold Limited completed a modest program on the Diadem Mountain volcanogenic massive sulphide deposit, near Jervis Inlet and Homegold Resources Limited drilled two short holes on the Doctor's Point gold property, near Harrison Lake.

There were also grant-assisted prospecting successes on the Mainland. Arnd Burgert discovered a possibly volcanogenic sulphide lens in Gambier Group volcanic rocks in a pendant in the Coast Plutonic Complex, north of Sechelt. In addition, Peter Newman conducted a second year of exploration on his Skumakum claims, northwest of Pemberton, and extended a previously discovered zone of deformed massive sulphide. The rocks are similar to and only a few kilometres along strike from, those found at the Avalanche prospect, which Teck Corporation drilled in 1993.

ACKNOWLEDGMENTS

The author gratefully acknowledges the contribution numerous prospectors, public and private sector geologists and other professionals have made to this report. Without their support, exploration reviews would not be possible.

SOUTH-CENTRAL REGION

By Michael S. Cathro, P.Geo.
Regional Geologist, Kamloops

SUMMARY

Highland Valley Copper produced at full capacity during the year, but profitability suffered due to the deterioration in copper prices. In early 1999, the company announced an indefinite shutdown beginning May 15, 1999. The mine employs 1046 people.

The **Blackdome** gold-silver mine, owned by Claimstaker Resources Ltd. and Jipangu Inc., was re-opened in fall, 1998 (Figure 1).

A permit was granted for a 100 000 tonne per year, open pit, thermal coal mine at the **Tulameen** project. Test mining and marketing are planned for 1999.

The **Prosperity** gold-copper project of Taseko Mines Ltd. is being reviewed under the Canada and British Columbia Environmental Assessment Acts. In mid-1999 the company plans to submit a Final Project Report for review by governments and stakeholders. A feasibility study is being completed by Kilborn-SNC Lavalin.

Several small industrial mineral projects were advanced towards production, including **Ashcroft** (roofing granules), **Z2** (zeolite), **Bud** (bentonite) and **Frenier** (perlite).

It was a very slow year for exploration in the South-central Region with only nine major projects (vs. 26 in 1997), $4 million in spending (vs. $17.6 million), and 14 000 metres of drilling (vs. 92 000 metres). Up to the end of November 1998, the number of new mineral claim staked was up strongly to 6224 units. Unfortunately, the number of forfeited claims was even higher at 11 483 units.

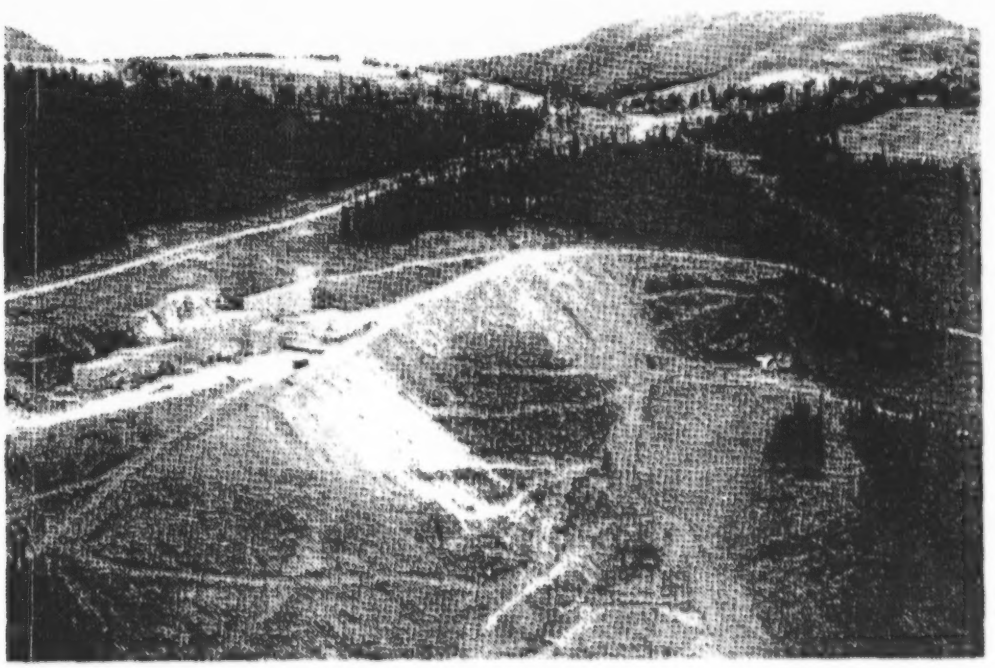

Figure 1. View of the Blackdome underground gold mine, owned by Claimstaker Resources Ltd. and Jipangu Inc.

EXPLORATION TRENDS

All exploration indicators for the South-central Region registered sharp declines in 1998, confirming that it was by far the slowest year for exploration in recent memory. Industry representatives cited bearish capital markets, weak metal prices and uncertainty over native land claims and park creation as the main reasons for the downturn.

Exploration spending for 1998 is estimated at only $4 million, compared with $17.6 million spent in 1997 (Figure 2). Drilling activity also showed a decline, from 92 000 metres in 1997 to an estimated 14 000 metres in 1998 (Figure 3). There were nine major exploration projects (defined as those with drilling or significant mechanical disturbance and at least $100 000 in spending) compared to 26 in 1997 (Figure 4). . Details of the 1998 exploration projects are listed in Table 1 and their locations are shown on Figure 6.

In terms of claim staking, 1998 showed a significant increase in activity, with 6224 new claim units staked (Figure 5). Unfortunately, there was an even greater increase in claims forfeited, to 11 483 units. The result is a net loss of over 5200 claim units, equivalent to perhaps 100 000 hectares of tenure. The large number of forfeited claims is at least partly due to the expiration of ten-year assessment credits which were applied to claims during the last exploration boom, the period of flow-through tax credits in the late 1980s.

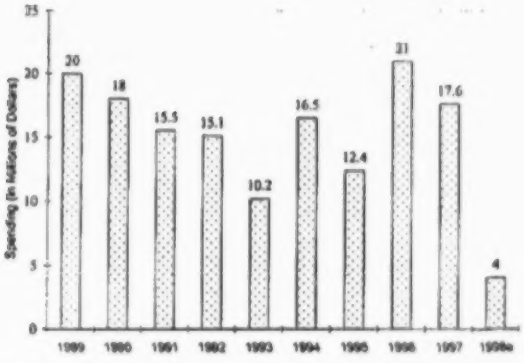

Figure 2. Annual exploration spending, in millions of dollars, South-central Region.

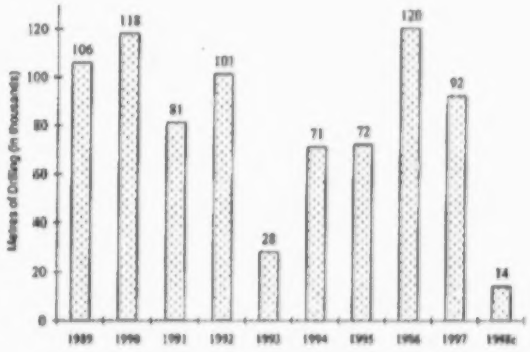

Figure 3. Annual exploration and development drilling, in thousands of metres, South-central Region.

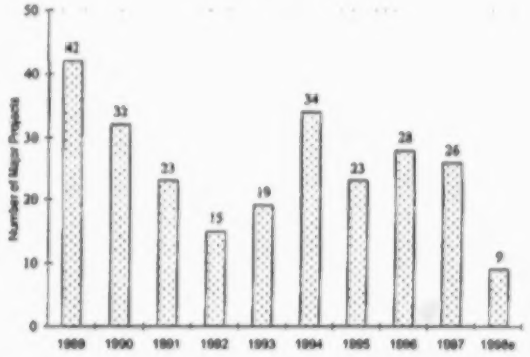

Figure 4. Number of major exploration projects per year, South-central Region.

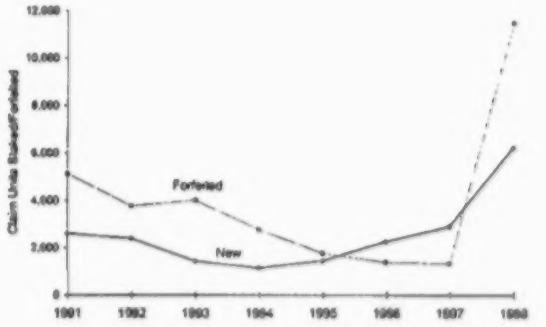

Figure 5. Number of new claim units staked vs. claim units forfeited per year, South-central Region. Source: Mineral Titles Branch.

Figure 6. Operating mines, development projects and major exploration projects, South-central Region. 1998.

TABLE 1. MAJOR EXPLORATION PROJECTS, SOUTH-CENTRAL REGION, 1998

Property	Operator	MINFILE Number	Mining Division	NTS	Commodities	Deposit Type	Work Done
Bonaparte Gold	Orko Gold Ltd.	92P 050	Kamloops	92P/01W	Au, Ag	Vein	21 ddh, 1103 m; 1 trench
Getty North	Getty Copper Corp.	92INE038	Kamloops	92I/10W, 11E	Cu	Porphyry	Site clearing in prep. for 1500-tonne bulk sample; baseline environmental studies
Millenium	APAC Minerals Inc.	82LNW021, 023	Vernon	82L/14E	Pb, Zn, Ag, Cu	Sedex	4 ddh, 732 m; 187 m trenching; geochem
Murphy Lake, Ann, Peach Melba	G.W.R. Resources Inc.	93A 044, 92P 002, 35, 108, 113, 115, 120	Clinton	93A/04E, 03W, 92P/14W	Cu, Au, Mo	Porphyry	11 ddh, approx. 1200 m
Newmac	Ascot Resources Ltd. / Canevex Resources Ltd.	92N 021	Clinton	92N/10E, 15E	Cu, Au, Ag	Porphyry	4 ddh, 875 m
Pellaire	International Jaguar Equities Inc.	92O 045	Clinton	92O/04E	Au, Ag	Vein	9 u/g ddh, 2 sfc ddh, approx. 600 m; geochem; prosp
Red Hill	Teck Exploration Ltd.	92INW042	Kamloops	92I/11W	Cu, Zn, Pb, Au, Ag	Volcanogenic Massive Sulphide	5 ddh, approx. 750 m
Tulameen Coal	Royal Scot Minerals Inc.	92HSE157	Similkameen	92H/10E	Coal	Sedimentary	10 ddh, 1022.7 m, coal quality testing; trenching; environmental baseline studies
Watson Bar (Second Cr.)	Stirrup Creek Gold Ltd.	92O051, 110	Lillooet	92O/1E	Au, Ag	Epithermal Vein	12 ddh, 2119 m; trenching; prospecting

MINES

The **Highland Valley Copper** (HVC) mine, a partnership of Cominco Ltd. (50%), Rio Algom Ltd. (33.6%), Teck Corporation (13.9%) and Highmont Mining Corporation Ltd. (2.5%), operated at full capacity during the year, and managed to increase the volume of concentrate produced as a result of higher mill throughput. The profitability of the mine deteriorated in the fourth quarter, however, due to the drop in copper prices to the US$0.65 per pound range, compared with US$1.03 in 1997. Over the full year the operation posted a profit of 32 million dollars (net of hedging gains). Production totaled 48 964 000 tonnes at an average grade of 0.393 % Cu and 0.008 % Mo. Metal contained in concentrate totaled 166 672 tonnes of copper, 2400 tonnes of molybdenum, 65 090 ounces of silver and 438.2 kilograms of gold. Reserves remaining at the beginning of 1999 are 416.8 million tonnes grading 0.418 % Cu and 0.0087 % Mo (Lorne Bond, personal communication, 1999). On January 18, 1999 HVC announced that the mine would shut down indefinitely due to economic conditions, beginning on May 15. Discussions on ways to lower the operating costs and avert the shutdown are taking place with the provincial government, B.C. Hydro, unions and suppliers. The mine employs 1046 people.

In the spring, HVC and the provincial government announced that they had signed a Memorandum of Understanding under the "Power for Jobs" initiative, which is intended to provide for the negotiation of competitively priced power for new investment projects. HVC studied the feasibility of building a hydrometallurgical copper refinery on the site and extending the mine life to 2012 by deepening the Valley pit. Unfortunately, the study found that these projects were uneconomic.

Located near Clinton, the high-grade, underground **Blackdome** gold-silver mine was re-opened on October 10, 1998 after being closed for eight years. The mine employs about 65 people. Only a small amount of gold was produced during the start-up period, and the mine was expected to reach its design milling rate by late December. Production of about 35 000 ounces gold is forecast for 1999. At year end, Jipangu Inc. of Japan exercised its option to increase its interest in the mine to 50%, with operator Claimstaker Resources Ltd. holding the remaining 50%. Reserves at startup were reported as 128 627 tonnes grading 14.0 g/t Au in the proven and probable categories. The total, fully diluted resource, including drill-indicated resources, is 237 881 tonnes grading 13.1 g/t Au and 37.1 g/t Ag (Claimstaker Resources Ltd. News Release, May 27, 1998). An aggressive exploration and development program is planned for 1999.

Gold at Blackdome is hosted in high-grade shoots within an anastamosing swarm of narrow, epithermal quartz-adularia-carbonate-sulphide veins that cut Tertiary volcanic rocks. Gold and silver occur as native grains and electrum, which are associated with sulphide and sulphosalt minerals (Church, 1987). Between April, 1986 and January, 1991 a total of 336 039 tonnes were milled with recovery of 7.213.7 kilograms (231 925 ounces) gold and 25 589.2 kilograms (822 710 ounces) silver. The average recovered grade was 21.5 g/t Au and 76.1 g/t Ag (MINFILE).

The large, low-grade **Similco** porphyry copper-gold mine, owned by Imperial Metals Corporation, closed in September, 1996. It remains on care and maintenance pending an improvement in metal prices. A resource of 142 million tonnes grading 0.397% Cu has been outlined in the area of Pits 2 and 3 on the Copper Mountain side of the property (Imperial Metals Corp. Annual Report, 1997).

Numerous small mines and quarries operated throughout the region during the year. M Seven Industries Ltd. produces magnetite by reprocessing tailings from the old **Craigmont** copper mine near Merritt. The magnetite is used in coal washing plants throughout western Canada. Lafarge Canada Inc. operates the Kamloops cement plant which is supplied by several quarries on an intermittent basis, including the 200 000 tonne per year **Harper Ranch** quarry (limestone), the 20 000 tonne per year **Falkland** quarry (gypsum), and the 15 000 tonne per year **Buse Lake** quarry (alumina-silica-rich rock). At **Pavilion**, Continental Lime Ltd. operates a limestone quarry and lime kiln. Western Industrial Clay Products Ltd. operates the **Red Lake** quarry which supplies diatomaceous earth to a plant in Kamloops. The company produces kitty litter, barn deodorizer and industrial absorbents. Highwood Resources Ltd. produces limited quantities of zeolite from its **Z1** quarry near Cache Creek. The company is targeting development of the turf grass and agricultural markets. Sadly, Franz Capital Corporation's **Kingfisher** marble quarry, located northeast of Vernon, went into receivership in 1998. The mine produced attractive white and grey-banded marble blocks which were processed into cut and split ashlar.

DEVELOPMENT PROJECTS

The **Prosperity** copper-gold project of Taseko Mines Ltd. is located at Fish Lake, southwest of Williams Lake. A very large open pit mine is proposed and Taseko has commissioned a $5 million feasibility study to be completed by Kilborn-SNC Lavalin in mid-1999. Based on 143 945 metres of drilling in 326 holes, Independent Mining Consultants, Inc. calculated a mineable reserve (proven and probable) of 631 million tonnes grading 0.254% Cu and 0.464 g/t Au. At the planned milling rate

of 110 000 tonnes per day, the operation would produce an average of 86 180 tonnes (190 million pounds) of copper and 14 300 kilograms (460 000 ounces) per year over the first 10 years of a 21-year mine life. Years 16 to 21 would see the milling of low-grade stockpiles (Taseko Mine Ltd. News Release, January 21, 1999). The overall, life-of mine stripping ratio would be 1.89:1. The project is proceeding through its review under the Canada and British Columbia Environmental Assessment Acts. During the year the company received its "Project Report Specifications" (terms of reference) for the Final Project Report, The report will be submitted to the Project Review Committee in mid-1999. In addition, the company signed a Cooperative Resource Development Protocol with the provincial government under the "Power for Jobs" initiative, which will allow for the negotiation of favourable power rates for the mine.

Near year-end, Taseko completed a 20 hole program of geotechnical and grade-confirmation drilling as part of the engineering and feasibility studies of the project.

The **Tulameen Coal** project, located 20 kilometres northwest of Princeton, was explored with ten diamond-drill holes, totaling 1023 metres, and a small pit (Figure 7). Numerous coal quality tests and engineering and environmental baseline studies were also completed. In December, 1998 a permit was granted for a 100 000 tonne per year thermal coal mine. The product is destined for cement plants and other small industrial users in the Lower Mainland and southern interior. The coal leases are owned by Pacific West Coal Ltd. and optioned to Royal Scot Minerals Inc., a subsidiary of Rackwood Mineral Holdings plc. The proposed mine is directly north of the former producing underground and open pit Coalmont (Blakeburn) Collieries, which operated between 1912 and 1957. The main coal seam is between 18 and 34 metres thick and dips easterly at 28 to 45°. The high-volatile bituminous B and C rank coal is Tertiary in age and contains shale and bentonite partings. Initially, the company will selectively mine the coal to meet cement market specifications, however, a wash plant is contemplated in the future. Total recoverable reserves are 11.2 million tonnes at a 3:1 stripping ratio. At a 1.03:1 ratio, reserves total 2 915 000 tonnes. At start-up, the project could employ up to 30 people, including trucking jobs (Royal Scot Minerals Inc., Tulameen Coal Project, Permit Application, April, 1998).

Stripping began on the **Getty North** deposit of Getty Copper Corp., in preparation for mining a 1500-tonne bulk sample and SX-EW leaching tests. Financing difficulties caused a postponement of the test mining, although environmental baseline studies continued through the year. The Getty North deposit is estimated to contain a resource of 72.1 million tonnes grading 0.31% Cu, which includes a higher grade oxide resource of 10.0 million tonnes grading 0.40% Cu (Getty Copper Corp. Annual Report, 1997).

Figure 7. Small pit on the main coal seam, Tulameen Coal property. Coal layers (black) are separated by shale and bentonite (grey)

The proposed **Bralorne** gold mine project remains on care and maintenance status due to financing difficulties and the low price of gold. Financing difficulties have also affected the **Lumby** graphite-sericite project of The Quinto Mining Corp., which received a permit for a small mine in 1997.

Permitting is well underway for a basalt quarry and associated roofing-granule processing plant at **Ashcroft**. The project is being developed by Ontario-based IG Machine and Fiber Ltd., a subsidiary of IKO Industries Ltd. A 500-tonne bulk sample was taken, and engineering and environmental studies were completed in 1998. Under the proposal, 250 000 tonnes per year of Nicola Group basalt would be mined, crushed, sized and coloured at the Ashcroft site, and then shipped to roofing shingle plants in Calgary, Alberta and Sumas, Washington. Unsuitable material would be marketed as fillers, road sand and pavement additives. The operation will employ 60-70 people and require a capital investment of $20 million.

Also at Ashcroft, C2C Mining Corp. has built a $1 million zeolite processing plant (Figure 8) to produce barn deodorizers, feed binders, cat litters and industrial absorbents. A packaging facility employing seven to twelve people is also planned. The plant has a capacity of 40 000 to 50 000 tonnes per year and will be supplied from the **Z2 zeolite deposit**, located east of Cache Creek.

The Z2 property was purchased from Highwood Resources Ltd. and includes a small quarry which is permitted to produce up to 10 000 tonnes per year. The Z2 deposit is reported to contain over 2 million tonnes of proven reserves (C2C Mining Corp. News Release, November, 1998), consisting of zeolite-altered, Eocene volcanic ash and shales (MINFILE 92INW095).

Near Princeton, Western Industrial Clay Products Ltd. collected bulk samples of zeolite and mixed Ca-Na bentonite from the **Bee 1-6** (Allenby) and **Bud** properties, optioned from Gordon Webster. The materials are being tested for use in Western Industrial's absorbent products, and may be able to displace bentonite currently being imported from Wyoming.

Finally, Perlite Canada Inc. has applied to bring the **Frenier Perlite** mine back into production at a rate of 25 000 tonnes per year. Located west of Clinton, the mine produced about 6000 tonnes of raw perlite between 1983 and 1986. Perlite is hosted in volcanic rocks correlated with the Kamloops Group (MINFILE).

In the Kelowna area, L. & D. Petch Contracting has begun bulk-sample quarrying at the **Gemini**, **Flag** and several other small quarries. Products are attractive gneiss and columnar basalt which are marketed as flagstone and landscape rock to the home construction industry, particularly in Alberta.

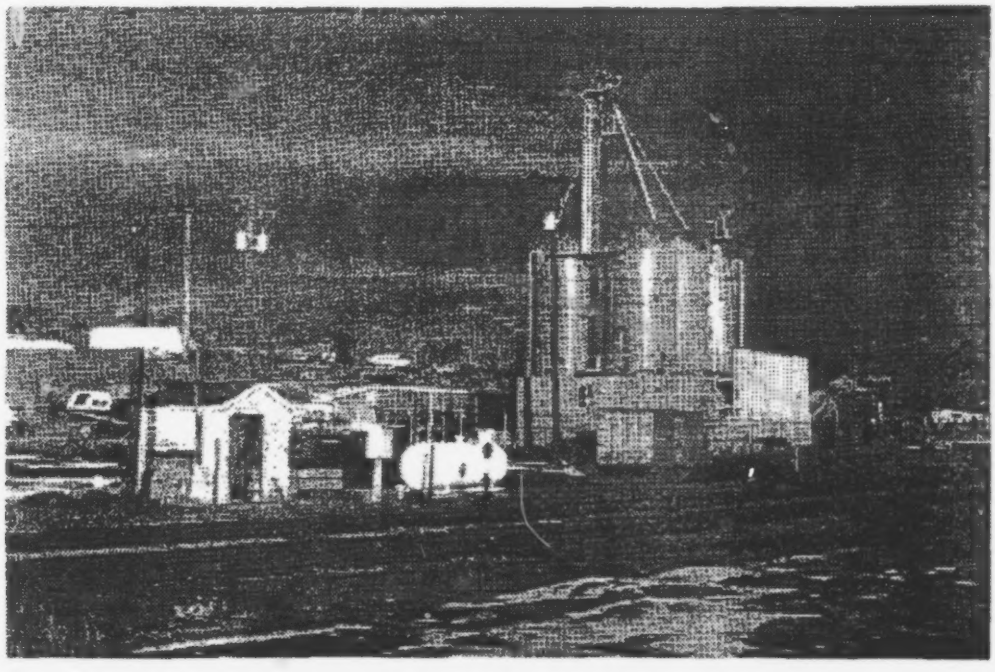

Figure 8. New zeolite processing plant and storage silos of C2C Mining Corp. at Ashcroft.

EXPLORATION PROJECTS

At the **Pellaire** project located southwest of Williams Lake, International Jaguar Equities Ltd. drilled nine underground and two surface holes to test high-grade, auriferous, quartz-telluride veins hosted by granodiorite of the Coast Plutonic Complex. The company also conducted a very extensive regional stream-sediment sampling and prospecting program in the surrounding area, looking for vein and porphyry-style mineralization. It was successful in discovering a new area of oxidized copper mineralization named **Charlie Northwest** and interpreted as representing leached and altered porphyry copper mineralization. Jaguar also conducted an I.P. survey, geochemistry and some mapping on the **Chita** (MF 92O 049) porphyry copper-molybdenum prospect on the east side of Taseko Lake, and hope to drill this property in 1999 (Figure 9).

Orko Gold Corp. drilled 1103 metres in 21 holes on the **Bonaparte Gold** property located 40 kilometres north of Kamloops. Six of the holes intersected ore grade gold mineralization over narrow intervals (0.5-1.5 metres), the best of which was 1.5 metres grading 22.0 g/t Au. At least seven, narrow, east-dipping, auriferous quartz-sulphide veins are known to be hosted by a small body of quartz diorite of probable Jurassic age.

In 1994, Claimstaker Resources Ltd. mined and shipped approximately 3800 tonnes of ore grading about 25 g/t Au from an open cut on the Bonaparte veins (Orko Gold Corp. News Release, October 1, 1998).

North of Lillooet, Stirrup Creek Gold Inc. continued drilling for epithermal gold mineralization on the **Watson Bar (Second Creek)** property. A total of 12 holes tested several new targets as well as possible extensions to Zone V, the main mineralized zone, where a geological reserve of 136 962 tonnes grading 14.33 g/t Au has been defined. Although results were generally disappointing, several of the holes intersected strong alteration and/or mineralized fault zones similar to Zone V, and additional drilling is warranted.

On the **Red Hill** property south of Ashcroft, Teck Exploration Ltd., drill-tested two volcanogenic massive sulphide Cu-Zn-Pb-Ag-Au targets hosted by felsic to intermediate volcanic rocks. These rocks are Early Triassic in age and are interpreted by Childe *et al.* (1997) to be similar to the Kutcho assemblage in northern British Columbia which hosts the Kutcho volcanogenic massive sulphide copper-zinc deposit.

Near Sicamous, Apac Minerals Inc. did soil sampling, trenching and drilling on the **Millenium** property. The target is sedex Zn-Pb-Ag mineralization.

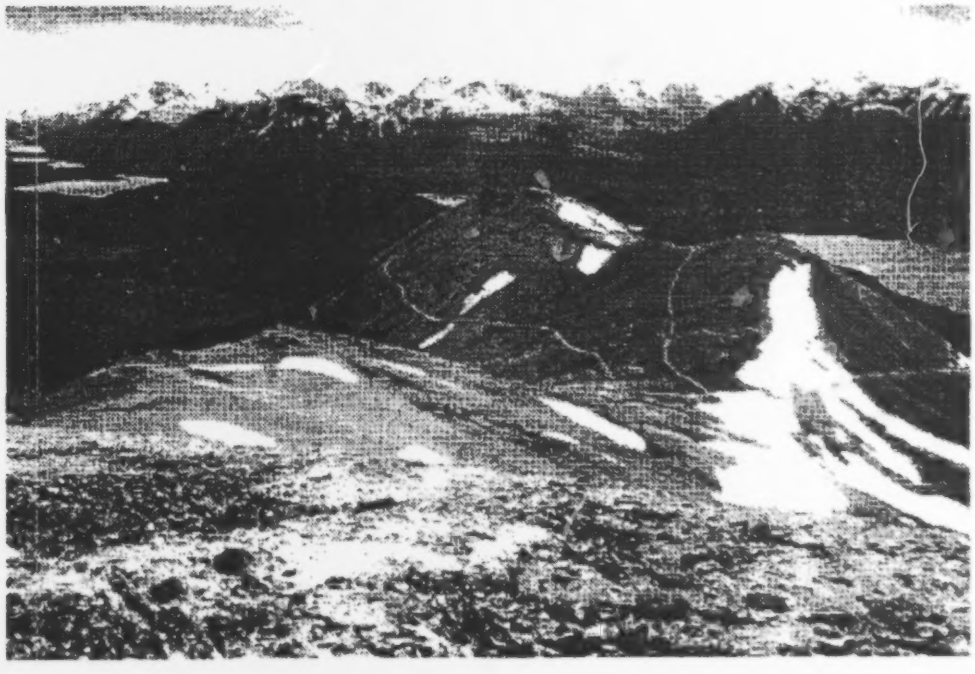

Figure 9. Exploration roads on the Chita porphyry Cu-Mo property, Taseko Lakes area.

The **Newmac** porphyry Cu-Mo-Au prospect near Tatla Lake was explored with four diamond-drill holes by Canevex Resources Ltd. and Ascot Resources Ltd. Results were mixed: the drilling confirmed the presence of a strong sulphide system hosted in volcanics, diorite, intrusive breccia and porphyritic rocks, however, copper values were generally subeconomic (Morton and Tregaskis, 1998).

Weymin Mining Corp. completed only minor fieldwork on the **McKinnon Creek** (J&L) volcanogenic massive sulphide Au-Zn-Pb-Ag deposit north of Revelstoke. The company did, however, contract H.A. Simons Ltd. to complete a scoping study on processing options and capital and operating costs for the project. The Simons study identified two options which were deemed to be economic; the first with all processing and milling taking place on site; and the second with combination of an on-site heavy-media separation plant and an off-site, regionally located mill. The study also indicated that Weymin must increase the reserves in the Main zone to at least 4 million tonnes from the current 3 607 000 tonnes grading 7.24 g/t Au, 3.93% Zn, 3.0% Pb, and 81 g/t Ag (Weymin Mining Corp. News Release, Oct 26, 1998).

GRASSROOTS WORK

Several interesting new discoveries were reported by individuals and small companies in 1998. While working under a Prospectors Assistance Program grant, Leo Lindinger discovered a new gold showing near Tumtum Lake in the upper Adams River watershed. He staked 24 units as the **Bizar and Biz claims** (also known as the Goldstrike property) in the early fall, and later optioned the claims to Cassidy Gold Corp. A series of narrow (1-20 cm), quartz-pyrrhotite-pyrite-chalcopyrite veins cut micaceous quartzite and biotite-muscovite schist of the Shuswap Metamorphic Complex. A chip sample, taken by the author, across a 20-centimetre vein returned 56.8 g/t Au, 3423 ppm Cu, 5270.5 ppm Bi together with anomalous cobalt, nickel, molybdenum, selenium, tellurium and tungsten. There are pegmatites and mid-Cretaceous felsic intrusions in the area. The geochemical signature and geological setting suggest this prospect may have similarities to the recently discovered Pogo deposit in Alaska.

Lindinger, and partner Dave Pipe, also optioned their **Ladybug** Ag-Zn-Pb-Cu property, located northeast of Chase, to Cross Lake Minerals Ltd. The property covers disseminated, vein and possibly stratiform sulphide mineralization in skarned marble and siliciclastic rocks mapped as Eagle Bay assemblage. Galena, sphalerite, chalcopyrite, magnetite and minor pyrite are present. Sampling by Cross Lake returned 9 metres grading 78.2 g/t Ag, 1.9% Zn, 1.19% Pb and 0.19% Cu. A high-grade sample assayed 550 g/t Ag, 7.42% Zn, 0.92% Pb, and 0.92% Cu over 0.5 metres.

South of Bralorne, the **Hope** claims were staked in late 1997 by Tom Illidge and Werner Gruenwald to cover Cu-Zn-Au-Ag mineralization discovered along a new logging road. The showings consist of disseminated to massive sulphides and magnetite-sulphide zones hosted in metavolcanic rocks of the Late Triassic Cadwallader Group. The owners believe there is potential for both volcanogenic massive sulphide and skarn-type deposits on the claims.

Finally, Merritt-based Aboriginal Investments Inc., a private company, did exploration work on several promising properties optioned from local prospectors. These include **Dot** near Logan Lake (Cu), **TUC** near Tulameen (Pt, Pd, Au, Cu, Ni, magnetite), and **East Barriere** (Au-Ag-Zn-Pb).

ACKNOWLEDGEMENTS

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KOOTENAY REGION

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SUMMARY

Exploration expenditures in the Kootenay region in 1998, including those at operating mines, are estimated to have totaled $11.1 million, a reduction of approximately 24% from the corresponding estimate for 1997 (Figure 1). Of that total, approximately $1.74 million represents the cost of exploration drilling in and close to producing coal mines in the Elk Valley, with the remaining $9.36 million spent on exploration for metals and industrial minerals throughout the region.

There were 176 projects (mineral, coal and placer) reported by submission of Notices of Work to the Mines Branch in 1998, about 24% fewer than the total logged in 1997 (Figure 2). More significantly, the total amount of exploration drilling in the region was only 60 250 metres in 1998, a reduction of 39% from the 1997 total of 98 664 metres.

These data indicate that the level of exploration activity in the Kootenay region, including that at the producing coal mines, has decreased significantly in 1998. Over the previous three years, the Kootenay region had shown a steady increase, particularly in the level of exploration spending and total drilling, in contrast to trends elsewhere in the province. However, in 1998 all the statistical indicators have registered a significant drop in keeping with the provincial trend. The decrease is due mainly to the reduction in exploration funding by major companies and the inability of juniors to attract investment as a consequence of low metal prices, the Asian economic crisis, and various political uncertainties. These problems are not unique to the region or to the province and it is expected that, when the current downturn for the industry is over, hopefully in 1999, exploration will again show an upward trend.

Non-coal exploration activity was again concentrated in the eastern part of the region where the largest expenditures and most aggressive drilling activity targeted Sullivan-style sedimentary exhalative (sedex) deposits in the Purcell anticlinorium. The most notable drilling success was achieved by Kennecott Canada Exploration Inc. on its Findlay property west of Canal Flats, optioned from the joint venture of Miner River Resources Ltd. and Eagle Plains Resources Ltd. In the final hole of its program, a 105.2 metre interval contained 46 thin, stratabound, sulphide layers mineralized with lead, silver and some zinc.

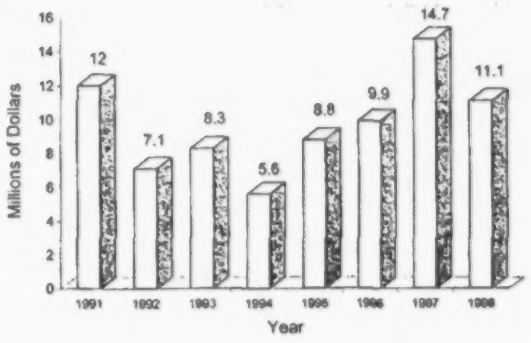

Figure 1. Exploration expenditures, Kootenay Region, 1998.

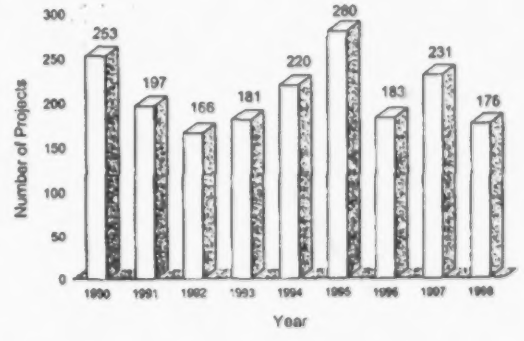

Figure 2. Exploration projects, Kootenay Region, 1998.

In the Kootenay Arc, there was one moderate sized drilling program, by Redhawk Resources Inc. at its Remac property, but most of the activity was grassroots exploration for zinc-lead (locally with silver or gold) mineralization. Reports of numerous high-grade silver-lead-zinc intersections by Cream Minerals Ltd. from its drilling on the Kaslo Silver prospect has encouraged increased property acquisition and activity in the Slocan silver camp.

Industrial mineral exploration in the Kootenay region was dominated by the activities of Anglo Swiss Resources Inc. at its Blu Starr gemstone property in the Slocan Valley. The original commodity of interest on the

Blu Starr claims was sapphires, but aggressive prospecting and product testing in 1998 has expanded the list of viable and abundant gemstones to include iolites, garnets, sapphires and several others.

Other industrial mineral projects of note include the Aspen feldspar prospect being tested by the R.H. Stanfield Group adjacent to its Bull River copper-gold property and the drilling of a barite prospect by WWC Consulting Ltd. on Jubilee Mountain, south of Golden.

There were no mine or quarry closures in 1998 but there are also no new mines being developed in the region at present. The five producing coal mines in the Elk Valley maintained steady production and continued with exploration and development drilling, although at a significantly reduced rate compared to the previous year. By year-end, the companies were implementing scheduled shutdowns as a belt-tightening strategy in response to reduced coal markets and prices.

At Cominco Ltd.'s Sullivan mine, the only producing metal mine in the region, re-evaluation of remaining ore reserves is an ongoing process, but it is still anticipated that the mine will be depleted and permanently closed late in the year 2001.

EXPLORATION HIGHLIGHTS

Table 1 gives details of the major metal, industrial mineral and coal projects in the region in 1998. The projects listed are those which involved significant expenditures on exploration drilling, bulk sampling or underground exploration work, or which are believed to have important regional implications. The locations of these major projects are shown on a regional map, Figure 3. Symbolic of the reduced level of activity in 1998, only two projects, Findlay and Bull River, reported expenditures in excess of $1 million.

METALS

PURCELL ANTICLINORIUM

The most important exploration target in the region continues to be Sullivan-style sedimentary exhalative (sedex) zinc-lead-silver mineralization in the Middle Proterozoic Aldridge Formation of the Purcell (Belt) Supergroup.These rocks occur mainly in the core of a north-plunging anticlinorium located between the east side of Kootenay Lake and the Rocky Mountain Trench fault. Remaining reserves in the giant Sullivan orebody, a major contributor to the economy of the region and the province for almost 100 years, will be depleted, and the mine is scheduled to close, in the year 2001. Extensive claim staking and accelerated exploration for the elusive successor to the Sullivan were stimulated by the release in 1996 and 1997 of data from a $600 000 multi-parameter airborne geophysical survey, which was financed by the provincial government and managed by the Geological Survey of Canada. Exploration in 1997, primarily by the joint venture of Kennecott Canada Exploration Inc. with the Hastings Management Group of companies, resulted in two sulphide discoveries and a number of new geological-geophysical target areas. Exploration in 1998, although hampered by reduced funding for all the operators, has resulted in at least one significant new discovery of stratabound mineralization and encouraging results sufficient to promise increased activity in 1999.

Kennecott Canada Exploration Inc. spent approximately $1.2 million in 1998 at its large **Findlay** property centred on the upper drainages of Doctor Creek, west of Canal Flats. The property, which is optioned from the 50/50 joint venture of Miner River Resources Ltd. and Eagle Plains Resources Ltd., is underlain by rocks of the Aldridge Formation ranging from Lower Aldridge at the south end of the claim group to Upper Aldridge and overlying Creston Formation at the north end. A thick, stratabound fragmental zone, anomalous in base metals and coincident with the Lower-Middle Aldridge contact (LMC or "Sullivan Horizon"), has been traced for several kilometres. Higher in the stratigraphy, extensive zones of tourmalinized, black meta-argillite (Photo 1), anomalous in lead and zinc and containing abundant galena-rich quartz veins (Minfile 082KSE060), have been mapped. During the 1997 and most of the 1998 field seasons, Kennecott covered the property with mapping, soil geochemistry and UTEM and gravity surveys, followed by five diamond-drill holes totalling 1853 metres. The first four holes were drilled in the southern part of the property, in the vicinity of the Sullivan horizon, with the only significant results coming in the fourth hole where an extensive sheeted vein system containing a best ICP analysis of 25 500 ppm Zn over 1.29 metres was reported. The fifth hole was drilled in the northern part of the property, adjacent to the area of extensive tourmalinization, and intersected significant silver and lead mineralization over an interval of 105.2 metres. Within that interval there are 46 narrow, stratabound sulphide horizons in thin-bedded siliciclastic rocks, tentatively identified as uppermost Middle Aldridge or Upper Aldridge. An ICP analysis of the total interval yielded 5.5 ppm Ag, 1460 ppm Pb, and 42 ppm Zn. Subsequent to the drilling of the fifth hole, Kennecott staked an additional 46 claim units to cover more of the favourable stratigraphy to the northeast.

On its **Greenland Creek** property, which adjoins the Findlay property to the south, the Miner River/Eagle Plains joint venture continued systematic mapping, prospecting and geochemical surveys in 1998. Prospecting in 1997 had recognized a stratabound, silver-lead-zinc-rich, sulphide breccia layer (Photo 2) within Lower Aldridge siltstones near the head of Greenland Creek. A seven-hole drill test in late 1997 traced the base

TABLE 1. MAJOR PROJECTS, KOOTENAY REGION, 1998

Property (Operator)	Minfile Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Aspen (R. H. Stanfield Group)	N/A	Fort Steele	82G/6W	Feldspar	Igneous	est. 10 ddh, 1800 m; product testing
Blu Starr (Anglo Swiss Resources Inc.)	082FNW259	Slocan	82F/12E	Gemstones	Metamorphic	bulk sampling, testing; prospecting
Bull River (R. H. Stanfield Group)	082GNW002	Fort Steele	82G/11W	Cu, Au, Ag	Mesothermal veins	1825 m u/g drifting; u/g dd, 6508 m; surface dd, 1500 m
Caramelia (Big Blackfoot Resources Ltd.)	082ESW018, 019, 020	Greenwood	82E/3E	Au, Ag,	Veins	7 ddh, 520 m; geophys; mapping
Elkview (Elkview Coal Corp.)	082GNE015	Fort Steele	82G/10W, 15W	Coal	Coal	35 rdh, 8030 m
Findlay (Kennecott Canada Exploration Inc.)	082KSE041, 060, 063	Golden	82K/1E	Zn, Pb, Ag	Sedimentary exhalative	5 ddh, 1853 m; geopyhs; geochem; mapping
Fording River (Fording Coal Ltd.)	082JSE009, 010, 012	Fort Steele	82J/2W	Coal	Coal	32 rdh, 14 686 m
Golden Crown (Century Gold Corp.)	082ESE032, 033	Greenwood	82E/2E	Au, Ag, Cu	Veins	u/g rehabilitation; trenching; mapping
Greenhills (Fording Coal Ltd.)	082JSE007, 001, 005	Fort Steele	82J/2W	Coal	Coal	19 rdh, 5200 m
Jubilee Mountain (WWC Consulting Ltd.)	082KNE079	Golden	82K/16W	Barite	Veins, breccias	diamond drilling; trenching; prospecting
Kaslo Silver (Cream Minerals Ltd.)	082FNW094, 095, 101	Slocan	82F/14E	Ag, Pb, Zn	Veins, shears, replacement	34 ddh, 3060 m; mapping; geochem; geophys
Lew (Sedex Mining Corp.)	082FSE115, 110	Fort Steele	82F/8E	Zn, Pb, Ag	Sedimentary exhalative	1 ddh, 701 m
Mammoth (Bluebird Minerals Ltd.)	082FSW211	Nelson	82F/6W	Cu, Mo, Ag	Skarn	4 ddh, 350 m
McGillivray (Fording Coal Ltd.)	082GNE009	Fort Steele	82G/10W	Coal	Coal	30 000 t bulk sample; 18 drill holes
McNeil Creek (Sedex Mining Corp.)	082GSW024	Fort Steele	82G/5W, 82F/8E	Zn, Pb, Ag	Sedimentary exhalative	1 ddh, 762 m
Paul-Mike (Dia Met Minerals Ltd. Cantex Mine Dev. Corp.)	N/A	Fort Steele	82G/13E, 12E	Zn, Pb, Ag	Sedimentary exhalative	1 ddh, 1139 m; seismic survey
Remac (Red Bird) (Redhawk Res. Inc.)	082FSW024, 219	Nelson	82F/3W	Zn, Pb, Ag	Sedimentary exhalative, replacement	3 ddh, ~1750 m
Wildrose (First Gold Resources Corp.)	N/A	Greenwood	82E/2E	Au, Ag	Veins	~100 m u/g drifting

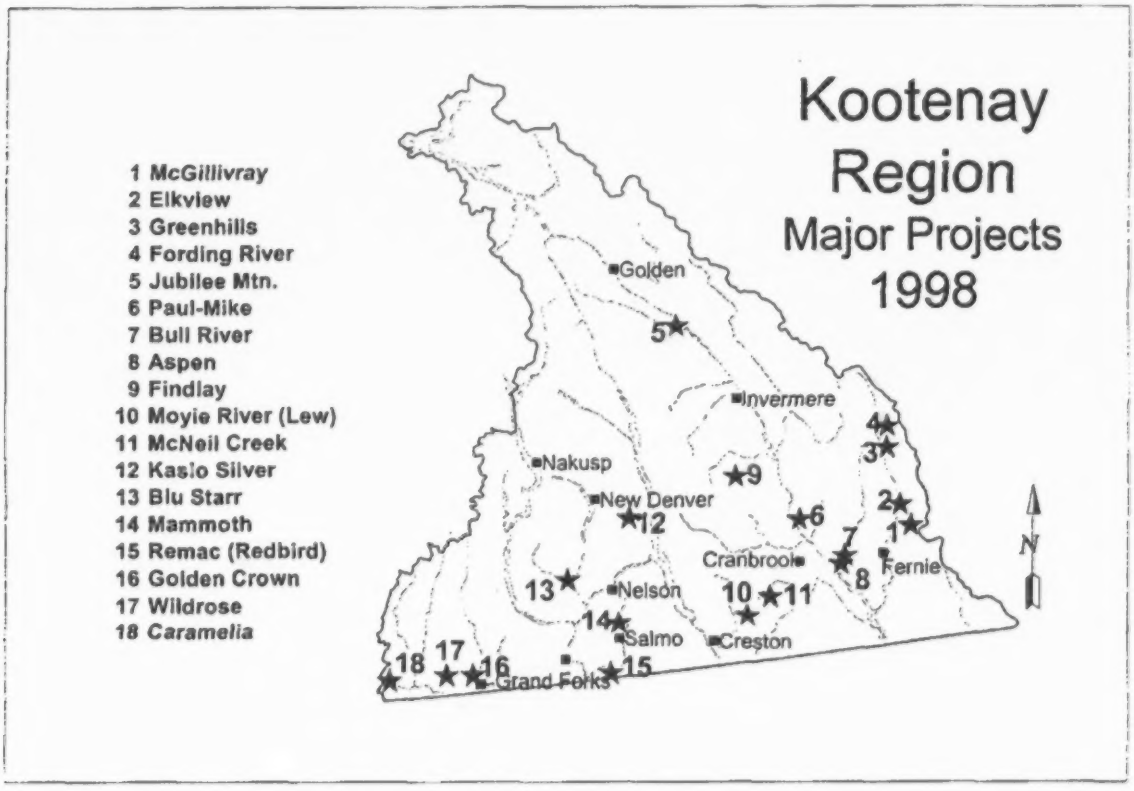

Figure 3. Major Projects, Kootenay Region, 1998.

metal sulphide bands and associated alteration downdip from the surface showing, returning a best assay of 6.06% Zn over 0.33 metre. Kennecott optioned the Greenland Creek property from Miner River and Eagle Plains late in 1998 and plans to explore it and the Findlay property as one major project in 1999.

Since 1996, Kennecott and the Hastings Management Group of companies (mainly Sedex Mining Corp. and Abitibi Mining Corp.) have been jointly exploring several large claim groups covering much of the Moyie River and Yahk-Creston areas. In 1997, Kennecott intersected 2.55 metres of massive to semimassive, coarse-grained sulphides grading 9.65% Zn, 5.82% Pb and 49.4 g/t Ag in a hole drilled in Panda Basin on its **Irishman** property. The intersection was considered particularly important due to its interpreted location on the edge of a major hydrothermal vent system in the Middle Aldridge, as indicated by stratabound and discordant fragmental units and widespread albite-tourmaline-chlorite-sericite alteration. In 1998, Kennecott deepened the drill hole by an additional 340 metres, for a total length of 1102 metres, in order to test the interpreted depth of the Sullivan horizon. Results of the drilling, and future plans for the Irishman project, have not yet been reported.

With limited funding compared to 1997, the Hastings Management companies completed modest drilling programs in several areas and report sufficient encouragement to warrant increased activity over much of their claim holdings in 1999. In the upper Moyie River area, Sedex Mining Corp. completed one drill hole, 762 metres long, on its **McNeil Creek** property, to test the Sullivan horizon adjacent to the east side of the McNeil Creek growth fault where narrow hangingwall veins are reported to contain up to 14% Pb and 2% Zn. The hole is reported to have intersected the target horizon at a depth of 342 metres, where it is represented by 27 metres of laminated argillites and siltstones containing pyrite, pyrrhotite and minor clots of sphalerite. At the **Lew** property, optioned from Cominco Ltd., Sedex extended a 1997 drill hole adjacent to the Lew tourmalinized fragmental vent by 700 metres. It is reported to have intersected the Sullivan horizon, represented by 11.6 metres of thin-bedded, silicified siltstones with minor visible sulphides, at a depth of 1405 metres. Elsewhere, Abitibi Mining Corp. drilled a 443 metre hole on the **Clair West** property optioned from Cominco and located west of Kimberley in the St. Mary Lake area. Abitibi also drilled three short holes, totalling 304 metres as an initial test of an extensive hydrothermal vent system outlined

Photo 1. Tourmalinite Ridge, Findlay property. Ridge comprised of tourmalinized siltstones, Middle Aldridge Formation.

last season on its **Yahk** property in the Cold Creek area, northeast of Yahk.

Ascot Resources Ltd. drilled two short holes, 250 metres each, on its optioned **Smoker** property at the head of Semlin Creek, west of Moyie Lake, to clarify the setting and geometry of the Smoker hydrothermal vent. Deeper drilling is planned for 1999. Ascot has also acquired the **DA vent** property near Lumberton, and has optioned the large **Cruz** property south of Moyie Lake from Chapleau Resources Ltd. Three vent systems in Middle Aldridge rocks, and a zinc-in-soil anomaly 2000 metres long, have been reported from the Cruz property, all of which require drill testing.

North of Cranbrook, in the Wasa Lake area, the joint venture of Dia Met Minerals Ltd. and Cantex Mine Development Corp. is currently drilling a deep hole on its **Paul-Mike** claim group, targeting Sullivan-style sedex mineralization on what they interpret as the down-faulted edge of the Kanasewich lineament. Early in 1998, the property was covered by a seismic survey which identified two large, strong anomalies coincident with weak IP anomalies outlined by previous work. The first vertical drill-hole was positioned to test one of the two seismic anomalies. It intersected what is described as a hydrothermally altered pyrite-pyrrhotite-chalcopyrite mineralized gabbro sill.66 metres thick. Drilling continued beyond the sill and beyond the interpreted depth of the seismic reflector and, at year-end, was at a depth of 1139 metres in "faulted" Middle Aldridge rocks. It is now planned to continue drilling to test the Lower-Middle Aldridge contact, the stratigraphic position of the Sullivan orebody.

At the **Bull River** mine property east of Cranbrook, the R.H. Stanfield Group continued with an aggressive and well-financed program of underground exploration in 1998. The 16% access decline had progressed to a total length of about 2000 metres by the end of the year and is still being extended. A total of 6508 metres of exploration drilling is reported from short drifts off the decline and a total of 1500 metres of surface drilling is also reported. The mineralization being explored consists of more than one set of parallel, east-trending, mesothermal quartz-carbonate veins cutting Middle Aldridge rocks and containing concentrations of massive chalcopyrite and pyrrhotite with gold and silver values. Placid Oil mined copper ore from two small surface pits on one of the vein sets in the 1970s. The most recent estimate of measured and indicated mineral resources published by the company for the Bull River mine is 5.3 million tonnes averaging 2.25% Cu, 36.3 g/t Ag and 12.0 g/t Au. The company plans to crosscut from the decline

Photo 2. Stratabound massive sulphide showing, Greenland Creek.

into the mineral zones on four levels for bulk sampling and metallurgical testing in 1999.

KOOTENAY ARC

The only major project in the Kootenay Arc in 1998 was the **Remac (or Red Bird)** project of Redhawk Resources Inc., on the south side of the Pend D'Oreille River opposite the former-producing Reeves MacDonald mine. Zinc-lead-silver-cadmium mineralization at the Reeves MacDonald occurred in four parallel, metamorphically modified sedex deposits within the Reeves limestone member of the Cambrian Laib Formation. All four zones plunge to the southwest onto Redhawk's claims and are repeated several times by north-dipping normal faults. The objective of the 1998 drilling program was to confirm and test the down-plunge continuity of the Annex zone. Three holes were drilled for a total of about 1750 metres. The drilling revealed that the zone plunges more steeply than previously thought, but has a down-plunge continuity of at least 366 metres in the fault block being explored. The best intersection was in the first hole (actually an extension of a 1987 hole) which assayed 7.61% Zn, 0.7% Pb and 53.8 g/t Ag over 10.3 metres. Much drilling remains to be done to properly assess the resource potential of the property, but the geological potential appears high for a large total tonnage of ore grading at least as high as that mined at the Reeves MacDonald.

Goldbank Ventures Ltd. excavated and sampled three trenches and drilled one short hole in the vicinity of the old adits on the **Goodenough** mine property on Ymir Creek, but were unsuccessful in locating additional ore below the old workings. At the **Surebet** property on Crawford Peninsula, several kilometres south of the former Bluebell mine, Cominco Ltd. drilled one 400 metre hole to test a strong geophysical anomaly in a geological setting favourable for Bluebell-style replacement mineralization. Vein mineralization was intersected, but the option has since been terminated. Exploration on Crawford Peninsula has been conducted periodically over a number of years, in an attempt to identify the source of high-grade massive sulphide boulders which are found in abundance over the whole peninsula. Cominco also excavated three trenches near an old showing on its optioned **Oxide** claims at Jubilee Mountain north of Porcupine Creek, with encouraging results, and continued its aggressive program of mapping, prospecting and other grassroots exploration in several parts of the southern Kootenay Arc.

Photo 3. Drilling at the Cork South zone, Kaslo Silver property.

Further north in the arc, at the **Silver Ridge** property on the Incomappleux River, 48 kilometres east of Revelstoke, Achieva Development Corp. drilled four holes, totaling 356.5 metres, adjacent to the Agnes adit (Minfile 082N033). The Agnes is one of a north-south string of showings on the property which were explored in the late 1890s for lead, silver and zinc. The mineralization is in quartz-carbonate veins and pods confined to a vertical shear zone in altered black argillites of the Lardeau Group. Achieva reported that its drilling located down-dip extensions of the Agnes vein, but that the overall grade was low.

SLOCAN AND NELSON CAMPS

The most significant metal project in the western part of the region in 1998 was the **Kaslo Silver** project of Cream Minerals Ltd., on Keen Creek, west of Kaslo (Photo 3). This high-grade silver-lead-zinc prospect, optioned from Eric and Jack Denny, comprises a string of former small mines and prospects stretching for 9 kilometres along Keen Creek, within a narrow septum of Slocan Group argillites and limestones projecting southward into the Nelson batholith. The significant mineralization is mainly of two types; shear-hosted disseminated ore in argillites and massive replacement ore in limestones. Both ore types are located along two complex, en echelon shear systems, one containing the Silver Bear, Gibson, Gold Cure and Bismark mines and the other connecting the Cork Province and Black Bear mines. The shear systems crosscut the strike of the sedimentary rocks at a shallow angle, allowing for the development of both ore types depending on the local lithology. The company spent $680 000 in 1998 and completed a total of 3060 metres of diamond drilling in 34 holes on several of the mineralized zones. In addition, comprehensive mapping, geochemistry and geophysics were carried out over a large grid covering the two shear systems. Highlights of the 1998 drilling reported so far include the intersection of a mineralized shear on the Bismark zone which assayed 313.7 g/t Ag, 0.73% Pb and 0.92% Zn over 9.3 metres, and an intersection of a replacement zone in the Cork South area which assayed 209.3 g/t Ag, 6.02% Pb and 8.09% Zn over a core length of 21.1 metres. The company plans to continue exploration of the property as long as funding is available and has stated an initial objective to define a minimum 5 million tonne resource of economic mineralization on the property.

An associated company of Cream Minerals, Sultan Minerals Inc., has optioned the **True Blue** volcanogenic

massive sulphide prospect located immediately west of the town of Kaslo, and plans to stage a modest, helicopter-supported, initial drilling program as soon as conditions permit in 1999. Recent chip samples collected from surface showings near the old workings averaged 6.75% Cu, 2.76% Zn, 0.12% Pb, 0.05% Co, 37.7 g/t Ag and 0.9 g/t Au.

Bluebird Minerals Ltd. drilled four holes, totaling 350 metres, on its optioned **Mammoth** gold-copper-molybdenum prospect, located south of Nelson on Commonwealth Mountain. The mineralization is skarn-hosted with local zones of porphyry-style brecciation, quartz stockworks and hydrothermal alteration. The mineralization is hosted by a pendant of augite porphyries and agglomerates of the Jurassic Rossland Group in a stock of porphyritic diorite and occurs only about 300 metres east of the Bonnington pluton. Old workings dating from early in the century contain widespread copper-molybdenum sulphides, and have been explored several times without much attention being given to the distribution of gold. The initial drill test by Bluebird Minerals was directed at strong IP anomalies in the vicinity of surface mineralization, with the additional objectives of assessing gold distribution and clarifying the geometry of any structural ore controls. One of the better intersections reported was 1.46% Cu, 0.082% Mo and 1.08 g/t Au over 3.28 metres in the third hole.

GREENWOOD MINING DIVISION

Activity in the Greenwood Mining Division was very limited in 1998, with only a few low-budget programs actually completed. The only significant drilling program was at Camp McKinney where Big Blackfoot Resources Ltd. drilled seven core holes totalling 520 metres, on the **Caramelia** property optioned from Consolidated Gold City Mining Corporation. The drilling contributed new geological information about some of the gold-silver-bearing quartz veins of the camp, but no economic gold grades were found in any of the holes.

Near the headwaters of Haus Creek, about 4 kilometres southwest of Greenwood, First Gold Resources Corp. explored the **Wildrose** gold-bearing massive pyrrhotite-pyrite vein underground by extending one of the existing drifts a distance of approximately 100 metres. The vein proved difficult to follow due to its variable thickness and frequent fault offsets. At the **Golden Crown** project, in the Wellington Camp southeast of the Phoenix mine, Century Gold Corp. carried out a comprehensive program of trenching and mapping the geological setting of the many gold-bearing veins on the property. Some rehabilitation of the underground workings was also completed and the company has plans for both underground exploration development and drilling to enlarge on known mineral resources beneath the formerly producing Golden Crown and Winnipeg mines. These two mines produced a total of about 55 000 tonnes of gold-silver-copper ore, hosted in both quartz and massive sulphide veins, in the early 1900s.

Late in the year, Solex Energy Inc. began a modest program of underground exploration of the gold-silver-bearing quartz vein at the **Gold Drop** mine east of Jewel Lake. At the **Old Nick** nickel-cobalt prospect near Bridesville, Applied Mine Technologies Inc. financed a program of mapping and magnetometer surveys early in the year. At year-end, Gold City Industries Ltd. was preparing to start a 1000 metre rotary drilling program on the property.

INDUSTRIAL MINERALS

Early in the 1990s, resident prospectors in the Slocan Valley recognized the gemstone potential of abundant corundum crystals occurring in syenitic gneisses of the Valhalla Gneissic Complex in the Passmore area. They staked the original **Blu Starr** claims and began extracting, shaping and polishing the corundum crystals and marketing them locally as natural star sapphires. Further prospecting located more rich corundum occurrences in the area and also revealed the presence and exceptional gem quality of other stones such as beryl, tourmaline and smoky quartz. Eventually their total claim holdings were purchased by Anglo Swiss Resources Inc. which began extracting small bulk samples of the sapphire-bearing rock, concentrating the gems and sending them away for heat treatment testing and other market evaluations, with very encouraging results in most cases. Meanwhile, Anglo Swiss continued to map and prospect the area intensively, employing the original owners to perform much of the fieldwork. The company also applied for placer designation of a part of the Slocan River valley, recognizing that the abundance of sapphires in the local bedrock should be reflected in viable concentrations of placer gems in the river gravels. The application was approved, placer claims have been staked and the company is now testing the possible placer resource. During the 1998 season, Anglo Swiss has greatly increased the potential of its property by not only finding a new large and very rich sapphire occurrence, but by discovering concentrations of exceptionally large and high-quality gem garnets and iolite (gem-quality cordierite). Early indications are that iolites of exceptional quality and colour may be sufficiently abundant to outstrip the original sapphire resource in economic importance. The significance of gemstones as an important mining resource in the Kootenays is starting to be acknowledged, mainly due to the aggressiveness, sophisticated management and success of Anglo Swiss and of the original prospector-discoverers.

The other major industrial mineral project in the region was **Jubilee Mountain**, south of Golden and just

west of Spillimacheen, where WWC Consulting Ltd. prospected, mapped, trenched and drill-tested a barite resource on claims optioned from prospector Art Louie. The claims are located immediately east of the former Silver Giant (or Giant Mascot) silver-lead-zinc-barite mine. The barite occurs in widespread veins and brecciated cavity-fillings (Minfile 082KNE079).

At its **Aspen** claims, adjoining its Bull River mine lease on the southwest, the R.H. Stanfield Group is exploring and testing an extensive stock of porphyritic syenite as a possible economic feldspar resource. The rock is comprised almost entirely of coarse-grained feldspar with minimal impurities. Work in 1998 consisted of a further 1800 metres of drilling and ongoing product testing.

Elsewhere, Highwood Resources Ltd. carried out limited exploration drilling in the vicinity of its producing **Parson** barite mine and explored other prospects in the area. Westroc Inc., operator of the Elkhorn gypsum mine at Windermere, conducted a program of exploration drilling and pre-development work at its **Kootenay West** gypsum property on the Kootenay River northeast of Canal Flats. Nugget Contracting Ltd., operator of the Horse Creek silica mine south of Golden, sampled and tested the silica potential of quartzite from a large outcropping of the Mount Wilson Formation on **Dart Creek**, east of Golden. San Pedro Stone Inc. collected some boulders of Coryell-aged granitic rock from its optioned **Gabe** claims on Gable Creek, north of Grand Forks, for initial testing as a possible dimension stone resource. The claims cover extensive outcroppings of massive, coarse-grained, uniformly textured granite with an attractive, soft pink colour.

PRODUCING MINES AND QUARRIES (FIGURE 4)

COAL

All five of the producing coal mines in southeastern British Columbia maintained steady production through most of 1998, but, by year-end, were starting to feel the impact of falling world prices and sharply shrinking markets for coking coal. Late in the year, the companies implemented scheduled shutdowns, an operational belt-tightening strategy which will be continued through 1999. Exploration and development drilling expenditures were also reduced from the 1997 levels.

Fording Coal Ltd. sold about 8 million tonnes of various grades of coking coal from the **Fording River** mine in 1998. Plant capacity was increased to about 9 million tonnes, but reduced coal sales late in the year resulted in a number of brief shutdowns in December. Approximately $800 000 was spent on exploration drilling and a similar amount on in-pit development drilling. The exploration drilling totalled almost 15 000 metres in 32 rotary holes, mainly in the Turnbull Mountain and Castle Mountain areas. Two deep exploration holes were drilled north of the Greenhills pit.

At Fording's **Greenhills** mine, total sales for the year were about 4 million tonnes, although plant capacity had been increased to 5 million tonnes. Scheduled shutdowns also limited production late in the year and will continue in 1999. Exploration drilling totalled 5200 metres in 19 rotary drill holes in the Cougar North Extension area at a cost of $390 000. An additional $500 000 was spent on in-pit exploration/development drilling.

Fording Coal Ltd. sold an estimated 1.8 million tonnes of coal from its **Coal Mountain** mine in 1998, about 60% of which was coking coal and the balance thermal and PCI coal. About $350 000 was spent on development drilling in active pit areas. A modest program of exploration drilling was completed in the Middle Mountain area just north of the mine. During the year, Fording acquired the **McGillivray** thermal coal prospect, a deposit of structurally thickened and sheared coal, adjacent to the Erickson fault on Michel Creek north of Coal Mountain. The previous owners had already been permitted for production of 800 000 tonnes over four years, but had been unable to establish a market for the coal. Fording mined a bulk sample of about 30 000 tonnes for test washing at Coal Mountain and drilled 18 exploration holes.

The **Line Creek** mine was acquired by Luscar Ltd. when it took over Manalta Coal Ltd.in mid-1998. Aside from a few management changes, there was little immediate affect on operations at Line Creek. Production for the year was predicted to total between 3 and 3.2 million tonnes, of which about 0.5 million is thermal coal. In-pit development drilling totalled about 19 000 metres with no other exploration activities conducted.

Elkview Coal Corp. at its **Elkview** mine also projected 1998 sales at 3 to 3.2 million tonnes. Exploration drilling amounted to a total of 8030 metres in 35 rotary drill holes in the Natal Ridge and Baldy pit areas. Development drilling was 2240 metres, mainly in the South Pit.

METALS

The only producing metal mine in the region is the **Sullivan** zinc-lead-silver mine at Kimberley operated by Cominco Ltd. The mine, which employs approximately 600 people, continued steady production through 1998 with a total of 1 915 700 tonnes of ore milled, averaging 6.0% Zn, 3.5% Pb and 22 g/t Ag. Proven and probable ore reserves as of December 31, 1998, are reported to be 6.1 million tonnes averaging 6.6% Zn, 3.7% Pb and 20 g/t Ag. No outside exploration was conducted in the vicinity of the mine in 1998, but systematic re-evaluation of

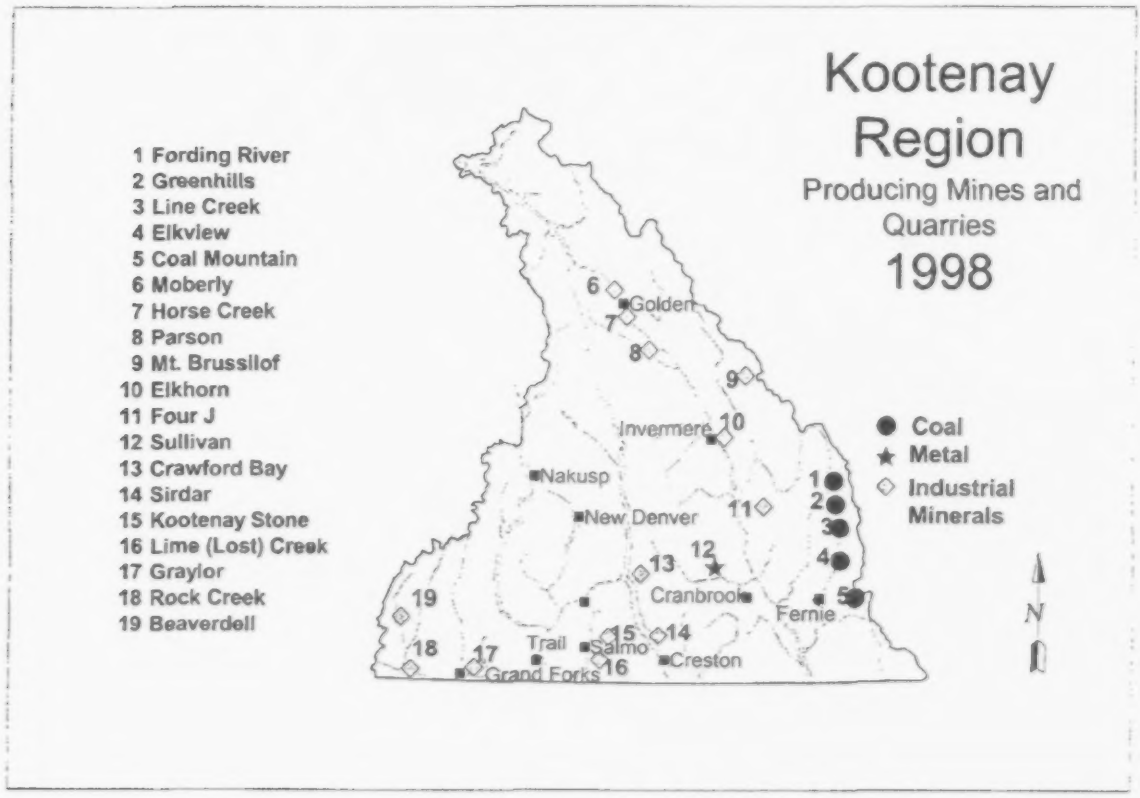

Figure 4. Producing mines and quarries, Kootenay Region, 1998.

remaining ore within the mine was ongoing throughout the year. It is still expected that reserves will be depleted and the mine will close permanently in late 2001.

INDUSTRIAL MINERALS

At its **Mt. Brussilof** mine, northeast of Radium Hot Springs, Baymag Mines Co. Limited shipped a total of about 200 000 tonnes of magnesite to its processing plant at Exshaw, Alberta. No exploration work was carried out in 1998. With little storage capacity at the plant, quality control at the mine is a major concern and the company has developed a sophisticated, computer-based system for detailed grade blending in the mine.

Westroc Inc. produced approximately 500 000 tonnes of gypsum from its **Elkhorn** mine east of Windermere (Photo 4). The mine employs 25 people and ships its product to its own plants in Vancouver and Calgary, to be used in the manufacture of wallboard and other products. Georgia Pacific Inc. continued to mine gypsum from its Four J quarry on the Lussier River and to ship the product from its rail-loading facility at nearby Canal Flats.

In the Golden area, Highwood Resources Ltd. mined and shipped about 150 000 tonnes of silica to from its **Mt. Moberly** quarry to various markets. Nugget Contracting Ltd. shipped approximately 65 000 tonnes of silica from its **Horse Creek** operation, mostly to Wenatchee, Washington for production of silicon metal. Highwood Resources continued producing barite from its underground mine at **Parson**, south of Golden.

IMASCO Minerals Inc. processed and shipped a total of about 60 000 tonnes of a variety of specialized industrial products from its processing plant at **Sirdar**, north of Creston. Raw materials are dolomite and limestone mined at its **Crawford Bay** underground operation, limestone mined intermittently from a small underground mine at **Lost Creek**, granite mined and crushed at Sirdar and quartzite mined from two small quarries near Crawford Bay. Mighty White Dolomite Ltd. quarries and processes dolomite near **Rock Creek**. **Kootenay Stone Centre**, near Salmo, produces quartzite flagstone from a number of small quarries in the Kootenay Arc and granite dimension stone is intermittently mined from two active quarries south of **Beaverdell**.

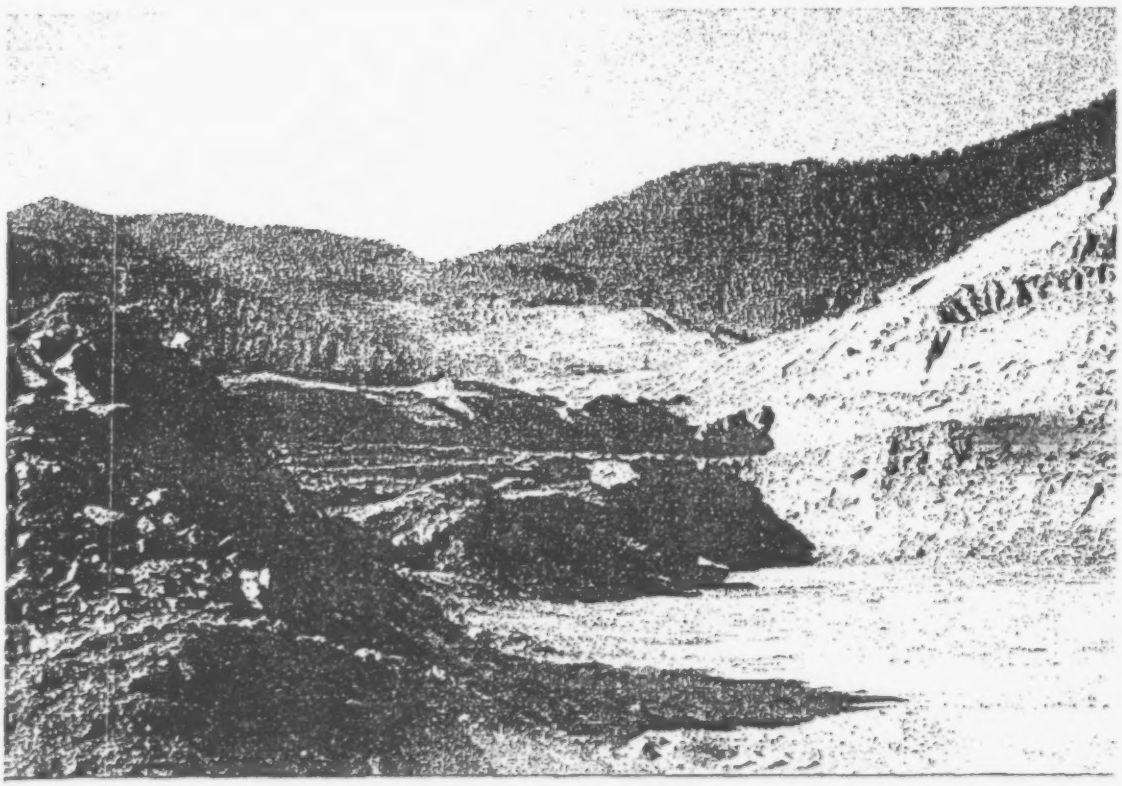

Photo 4. Windermere gypsum mine. Elkhorn quarry (foreground) and Elkhorn Extension (centre distance).

ACKNOWLEDGEMENTS

Thanks are due to the many industry managers, geologists and field staff who were willing to share their data and observations with the author and to provide access to their exploration properties.

Most of the material relating to coal activities in this report is derived directly from information acquired by Barry Ryan of the Geological Survey Branch. His compilation of the data and his generous sharing of it with the author are very much appreciated. The author also gratefully acknowledges the assistance of his colleagues in the Cranbrook regional office, particularly Maggie Dittrick and Valerie Smolik, who helped with preparation of the report and its illustrations.

PART B

GEOLOGICAL DESCRIPTIONS OF SELECTED PROPERTIES

GEOLOGICAL SETTING OF THE GIBRALTAR MINE SOUTH CENTRAL BRITISH COLUMBIA (93B/8&9)

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KEYWORDS: Gibraltar Mine, copper-molybdenite deposit, Granite Mountain Batholith, Nicola-Takla Group, Quesnellia terrane, Cache Creek terrane.

INTRODUCTION

This report summarizes preliminary results of detailed and regional geological mapping of the Gibraltar Mine and surrounding region conducted during August and September, 1998. The map area is situated between Quesnel and Williams Lake in east central British Columbia (Figure 1). Results of this mapping are presented in Open File map format at a 1:50 000 scale (Ash *et al.*, 1999). This work benefited from the active participation and input from Gibraltar Mines geological staff and Crest Geological consultants who are currently conducting exploration in the region. This work builds on earlier unpublished mapping in the area by Panteleyev and others (Panteleyev, 1977). Here we provide some related description and discussion to accompany Open File 1999-7 and also review recent mining and exploration activity in the Gibraltar region.

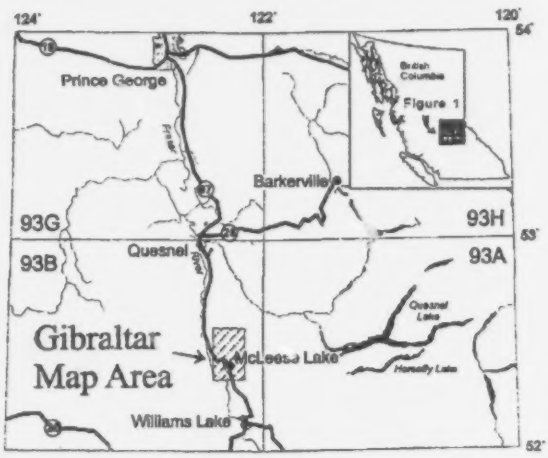

Figure 1. Location of the Gibraltar map area.

Systematic mapping of the mine region beyond the geographic limits of previous workers combined with the reinterpretation of certain units, has provided new insights into the geology of the region. These pertain specifically to relationships between the Granite Mountain Batholith and spatially associated Cache Creek accretionary complex rocks to the south and east, and volcanic-arc and related sedimentary rocks to the north. This reevaluation also has implications regarding the timing and origin of Cu-Mo mineralization at the Gibraltar Mine.

This revised interpretation is aided by a better understanding of the temporal, regional tectonic relationships for contiguous units throughout the Cordillera. In addition a relatively dense network of logging roads provided both ready access and increased bedrock exposure in this region which is largely obscured by glacial drift and alluvium.

PREVIOUS WORK

Tipper (1959) conducted regional scale, 1 inch to 4 mile geological mapping of the Quesnel, 93B NTS sheet. More detailed mapping of the local Granite Mountain area has coincided with exploration interest in the region (Figure 2). Sutherland Brown (1958) mapped and described the geology of the Cuisson Lake valley and area west. Eastwood (1970) was the first to document a large area of the Granite Mountain Batholith. Simpson (1970) documented the mineralogical, textural and structural character of intrusive rocks in the mine area. Panteleyev (1977) was the first to complete detailed systematic mapping (1 inch to 1/4 mile scale) of the entire batholith and surrounding lithologies.

Detailed descriptions of the immediate mine geology and associated mineralization that have included geological compilations are those of Drummond *et al.* (1973, 1976), Sutherland Brown (1967; 1974) and Bysouth *et al.* (1995). Humphrey (1968) completed a Ph.D. study of the Pollyanna property; a copy of this work, however, was not available.

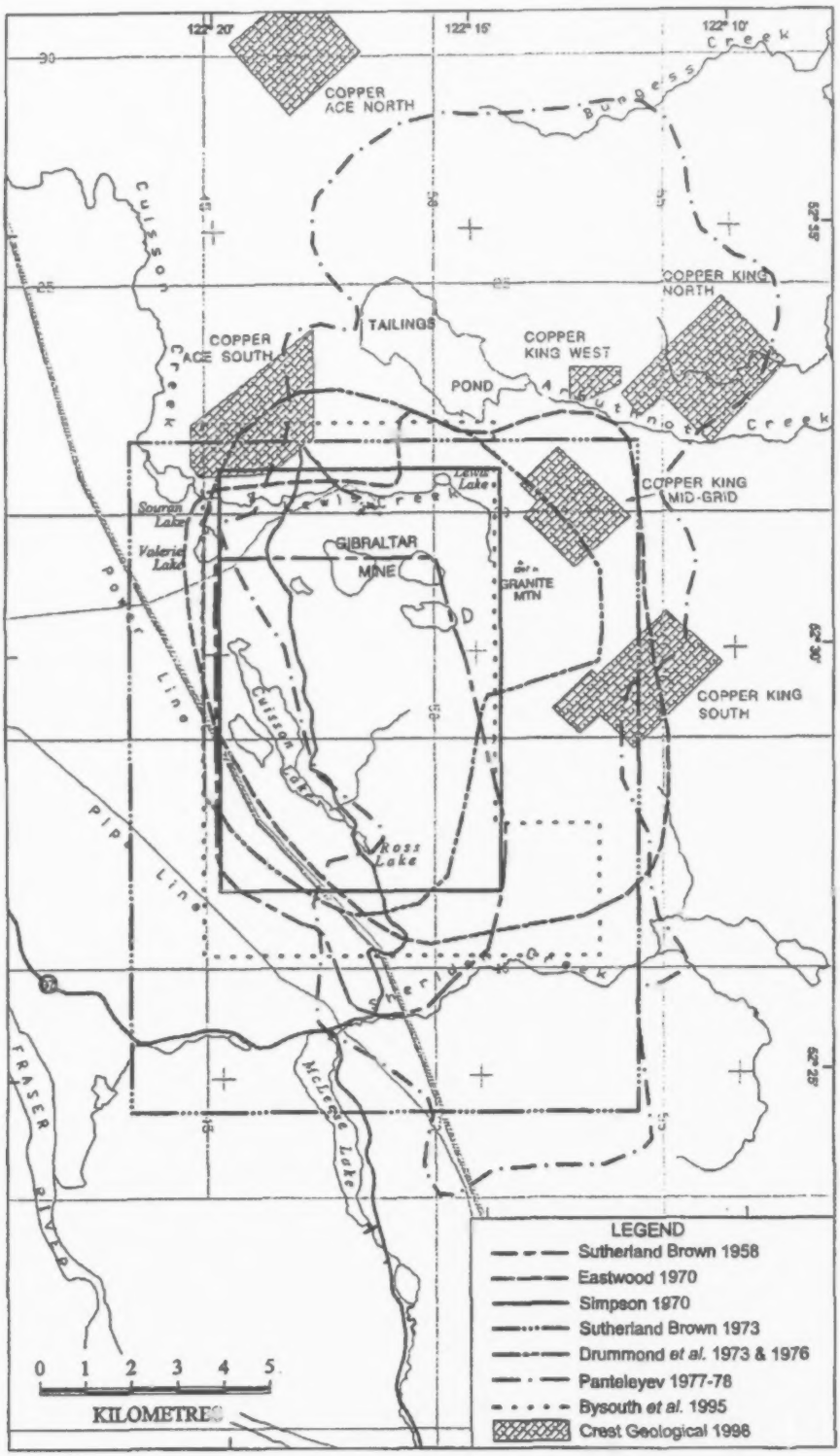

Figure 2. Map areas covered by previous workers in the Gibraltar region.

GEOLOGY

The Gibraltar map area overlies the eastern margin of the oceanic Cache Creek terrane where it is onlapped structurally by allochthonous arc-plutonic and volcanic rocks of Quesnellia. Arc-plutonic rocks, comprising the Granite Mountain batholith which is host to the Gibraltar copper-molybdenum deposit, dominate the map area. The batholith is a latest Triassic (Drummond, *et al.*, 1976; Bysouth, *et al.*, 1995) compositionally and texturally varied dioritic to tonalitic intrusion that has been variably deformed and recrystalized under greenschist-grade metamorphic conditions. A number of broad, high strain shear zones containing milled, mylonitic and recrystalized, schistose granitic rocks occur within and marginal to the batholith. It is in inferred faulted contact with Cache Creek accretionary complex rocks to southwest and southeast. These consist primarily of graphitic argillite with chert and ribboned chert, with lesser mafic volcanics and limestones. They occur primarily as melange and broken formation with shearing and folding common. Cache Creek rocks have been traditionally assigned a late Paleozoic age but no fossil data is available to constrain their age in this region. They could range from Late Paleozoic to early Mesozoic, consistent with the age range of Cache Creek accretionary complex rocks to the north (Cordey and Struik, 1996) and south (Cordey and Read, 1992) of this region.

Volcanic and sedimentary rocks exposed to the north and northeast of the Granite Mountain batholith were first documented by Panteleyev (1977). They were described as a succession of andesitic flows, breccias, greywacke, siltstone and conglomerates that were intruded by the Granite Mountain Batholith. Wheeler and McFeely (1991) correlated these rocks regionally with arc-derived clastics of the middle Jurassic Hall Formation. Existing field relationships suggest that the volcanic rocks are most likely coeval with the Granite Mountain Batholith and correlative with the lower Jurassic Takla Group.

Further southwest Cache Creek rocks are in high angle, faulted contact with pyroxene-phyric mafic volcanic flows and flow breccias regionally correlative with the Paleogene Kamloops Formation (Wheeler and McFeely, 1991). Flat-lying, olivine-phyric plateau basalts that regionally correlate with the Neogene Chilcotin Group (Wheeler and McFeely, 1991), unconformably overlie both these units. They are also reported to overlie foliated quartz diorite within the Cuisson Lake Valley (Sutherland Brown, 1958).

In general the contacts shown in Figure 3 are more or less consistent with that reported in previous mapping (Figure 2). Description and discussion is therefore focused on areas that have not been documented, or where our interpretation of a unit differs from that of previous workers.

Symbols given in brackets for individual units are the map designations presented by Ash *et al.* (1999).

CACHE CREEK ACCRETIONARY COMPLEX (PMC)

The best exposures of Cache Creek rocks are in the fault bounded wedge along the southwestern margin of the batholith. Several broad scale features are evident in the sporadic exposures of the unit throughout this heavily overburdened low-lying area. There is a prevalence of a more chaotic mix of units within the eastern half where volcanic rocks are also common. These mafic volcanic rocks near the contact with the batholith are commonly replaced by ankerite and zones of carbonate veining. A small zone of quartz-ankerite-mariposite±pyrite was noted in variably carbonate-altered volcanics due east from the southern end of McLeese Lake. Several samples that were collected and analyzed from this zone do not have elevated base or precious metals values.

Cache Creek rocks along the western side of the belt to the south are dominated by moderately disrupted sequences of bedded graphitic argillite, chert and ribbon chert. Occurrence of mafic volcanic rocks and limestone are rare and the volcanic rocks are not carbonate altered. Whether this difference in lithologic character reflects a regional stratigraphy within the Cache Creek is difficult to ascertain.

Areas designated as Cache Creek along the eastern side of the batholith are problematical. Only two outcrops, each consisting of limestone, were noted in the large area of Cache Creek in the east-central portion of the map sheet. Two of nine diamond drill holes by Gunn Resources in 1970 intersected graphitic argillite and ribbon cherts near the contact with the batholith. The remainder of the briefly described Gunn holes constrain contact relationships with the batholith in this area.

Designation of the area labeled PMCm(?), located roughly five kilometres east of McLeese Lake, remain uncertain. Limited outcrops in the area consist of either limestone or well bedded siltstone, both typically recrystalized. Without more mapping in this area designation of these sedimentary rocks as either PMCm or IJv remains uncertain. Both these lithologies are present as xenoliths within the leucocratic quartz diorite along the northeastern margin of the unit.

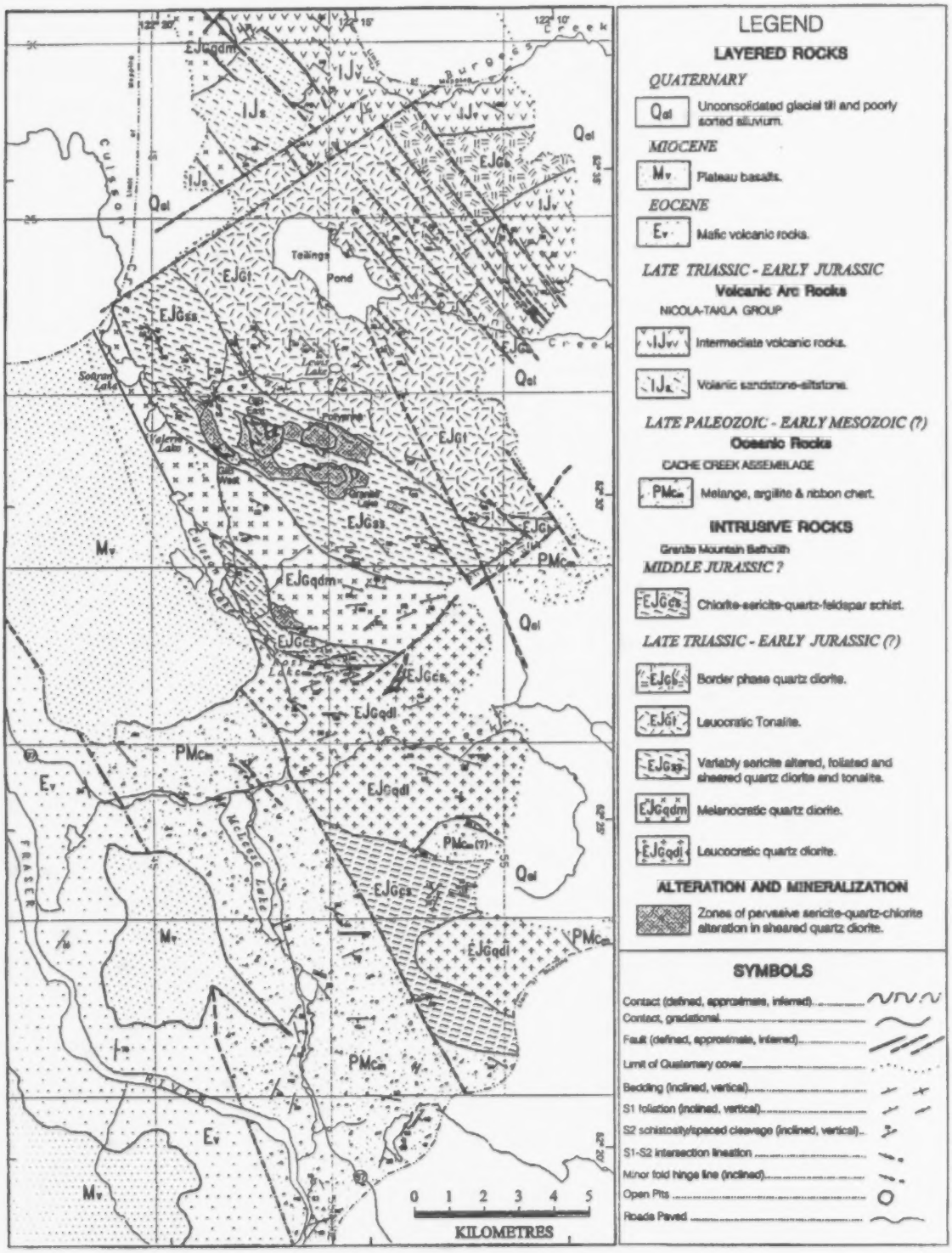

Figure 3. Geology of the Gibraltar map area. Simplified after Ash et al. (1999).

The most southwesterly area designated as Cache Creek includes two outcrops of variably ankerite-altered, mafic volcanic rocks which are similar in appearance to altered Cache Creek volcanic rocks to the west.

GRANITE MOUNTAIN BATHOLITH (EJG)

The Granite Mountain Batholith has traditionally been reported to be of Late Triassic age (Drummond *et al.*, 1976; Bysouth *et al.*, 1995). Wheeler and McFeely (1991) include it as part of the Early Jurassic Guichon Suite (187-214 Ma) which includes a series of large intrusive bodies, mainly within Quesnellia, which extend from Granite Mountain Batholith south to the British Columbia-Washington border and include the Guichon Batholith, host to the Highland Valley copper deposits.

Potassium-argon hornblende ages of 204 ± 6 and 203 ± 6 Ma (Drummond *et al.*, 1976) and a U-Pb zircon age of 217 ± 12 Ma, as well as a composite age ranging from 204 to 217 Ma (Bysouth *et al.*, 1995) from the Gibraltar mine area place constraints on the age of the batholith. Designation of the batholith as either Late Triassic or Early Jurassic is more a feature of the ongoing refinement for placement in terms of absolute age for the Triassic-Jurassic boundary (Harland, *et al.*, 1990; Pálfy, *et al.*, 1998). More significant, is that the absolute age of the intrusion is coeval, within error, with the earliest Jurassic age of 200 to 205 Ma, with a cluster at 203 (U-Pb zircon and titanite) for arc-magmatism in Quesnellia to the immediate east (Mortensen *et al.*, 1995; Panteleyev *et al.*, 1997), thus supporting the correlation presented by Wheeler and McFeely (1991), irrespective of its designated stratigraphic age. A sample of leucocratic tonalite collected roughly 1.5 kilometres north-northeast of the Gibraltar mill site is being analyzed by R. Friedman at the University of British Columbia to more precisely constrain the age of the batholith.

The mineralogy of the pluton is relatively consistent throughout, including plagioclase (30-70%), quartz (5-65%), and hornblende±biotite (trace-60%). Plagioclase is everywhere variably to completely saussuritized and mafic minerals are more commonly completely chloritized. Variation in both grain size and relative proportions of these minerals allow subdivision of the batholith into distinctive magmatic units or phases. Further subdivision is introduced due to lithologic changes resulting from the deformation and related recrystallization into metamorphic units.

Lithologic variations indicate that phases of the batholith are progressively more differentiated from southwest to northeast. An increase in both content and grain size of quartz from the southwest to the northeast of the batholith suggests an overall primary magmatic stratigraphy. The distribution of these units is presently attributed to modification of a differentiated intrusion by regional tectonic processes that have resulted in attenuation by shearing, folding and imbrication of the original intrusive body.

Terms previously assigned to the various units of the Granite Mountain Batholith have varied so we provide a summary with a brief description of previous nomenclature used for equivalent units. Individual units are distinguished on visual field estimates of the relative proportions of quartz and feldspar. Rock names are applied on the basis of the commonly used Q-A-P ternary classification scheme of Streckeisen (1975). Additional qualifiers such as leucocratic (mafic poor) or melanocratic (mafic rich) are added to these terms to further characterize the relative mafic mineral content of the units. Individual units are presented in order from least to most differentiated, based in large part on increased quartz content. The chlorite schist unit, which is presented last, as result of its metamorphic character is out of context in this regard, as its protholith is interpreted as the least differentiated phase of the batholith.

Although all primary feldspar minerals are generally regarded as plagioclase, petrographic evidence suggests that minor amounts of K-feldspar are present. Eastwood (1970) reported that minor interstitial perthite in places, suggests possible transitions to granodioritic compositions. Similarly, Sutherland Brown (1974) reported up to 10% K-feldspar in some samples collected from the Gibraltar mine area. Simpson (1970), on the other hand, noted that K-feldspar was absent in thin sections studied.

LEUCOCRATIC QUARTZ DIORITE (EJGqdl)

The relatively massive and unaltered body of medium to coarse-grained, leucocratic diorite to quartz diorite several kilometres northeast of McLeese Lake (Figure 3) was considered by some previous workers (Sutherland Brown, 1974; Eastwood, 1970) as the southern extent of the Granite Mountain Batholith. Simpson (1970) considered it a structurally distinct intrusion, which he termed the Iron Mtn. Pluton, to distinguish it from the inferred, older Granite Mountain batholith. Subsequent workers (Drummond *et al.*, 1973, 1976; Panteleyev, 1977; Bysouth *et al.*, 1995) also interpreted this to be a younger intrusion, of possible

Cretaceous age, which they referred to as the Sheridan Creek pluton or stock. Eastwood's (1970) subdivision of the batholith into massive quartz diorite and foliated quartz diorite to distinguish this unit from the remainder of the batholith adequately characterizes the obvious difference between the two. Previous mappers did not cover the body of leucocratic quartz diorite several kilometres east from the south end of McLeese Lake; therefore, discussion of previous work refers only to the larger, northerly exposed area.

This unit is the only plutonic phase in which primary mafic minerals, though partially altered, are readily identified in hand sample. In addition exposures are commonly massive and isotropic. It has been shown (Simpson, 1970; Bysouth *et al.*, 1995) that this body is texturally and compositionally similar to the least deformed and recrystallized rocks within the main batholith to the north.

Current mapping supports the view that this is a less altered and deformed segment of the batholith and not a discrete stock. Although commonly massive, areas with moderate foliation fabrics containing occasional high strain shear zones are evident throughout the body. Orientations of foliation fabrics within the unit are consistent with those in foliated plutonic rocks to the north. Also deformed and metamorphosed diorites and quartz diorite along the southern margin of the body suggest that it has experienced the same deformational history as the remainder of the batholith.

Previously, the obvious textural and compositional similarities between this body and the inferred older Granite Mountain Batholith were attributed to the individual magmas being generated from the same source region (Simpson, 1970; Bysouth *et al.*, 1995). Within the current understanding of Cordilleran geology it would seem unlikely that that magmas generated in a oceanic volcanic-arc setting in the latest Triassic would be similar to magmas generated below and intruded into the accreted margin in the Cretaceous.

A 137 ± 5 Ma K-Ar, hornblende age for this intrusion reported by Bysouth *et al.* (1995) can not be regarded as good evidence to suggest that it is younger. A summary of isotopic age data for the Granite Mountain batholith clearly shows that K-Ar dating of mafic minerals from the pluton displays significant scatter. A sample of the leucocratic quartz diorite is being analyzed by U-Pb zircon methods by R. Friedman at the University of British Columbia to more accurately establish its crystallization age.

MELANOCRATIC QUARTZ DIORITE (EJGqdm)

This unit is relatively mafic in character and typically well foliated. It contains 20 to 35% chlorite; 5 to 20% quartz with the remainder being variably altered plagioclase. It is generally coarse but locally medium-grained and pale gray-green to gray weathering. Primary mafic minerals are highly chloritized, and feldspars are strongly saussuritized.

Termed diorite by Eastwood (1970) and Simpson (1970) and mafic phase by Sutherland Brown (1974), the unit was later regarded as a batholith border phase by Panteleyev (1977) and Bysouth *et al.* (1995) and as a chloritized diorite marginal phase by Drummond *et al.* (1973, 1976). Authors applying the border or marginal phase terminology for the unit interpreted it to be the intrusive contact margin of the batholith. Its mafic character was considered to be the result of assimilation and recrystallization between the batholith and mafic-rich Cache Creek rocks. We interpret the unit to be a differentiated phase of the batholith, intermediate between the mafic-rich dioritic unit to the south (now largely deformed and recrystalized) and the more leucocratic quartz dioritic-tonalite unit to the north.

FOLIATED QUARTZ DIORITE-TONALITE (EJGqs)

This unit ranges from slightly cataclastic quartz diorite-tonalite to completely recrystalized fine to medium grained quartz-sericite-chlorite-feldspar schist and is distinguished by its structural and metamorphic character. It was included as part of the main quartz diorite by Drummond *et al.* (1973, 1976) and Sutherland Brown (1974). It was referred to as the mine phase quartz diorite by Panteleyev (1977) and as the mine phase tonalite by Bysouth *et al.* (1995).

Compositionally the unit is transitional between the melanocratic quartz diorite to the south and the leucocratic tonalite to the north. It comprises 50 to 60% altered plagioclase and 15 to 30% quartz. The mafic character of the unit is highly variable and appears to be accentuated by deformation. More leucocratic relatively massive, foliated zones of quartz diorite-tonalite (15 to 20% chlorite) are commonly separated by darker sheared and recrystalized chloritic zones that vary from several centimetres to several tens of metres in width.

Secondary sericite generally on the order of 2-5%, except where significantly enriched within zones of mineralization, is a readily identifiable and diagnostic feature of the unit.

LEUCOCRATIC TONALITE (EJGt)

This unit comprises the largest exposed area and most of the northern portion of the batholith and also displays the widest textural and compositional variability. It was included as part of the main quartz diorite by Drummond *et al.* (1973, 1976), termed the leucocratic, quartz diorite by Panteleyev (1977) and called the Granite Mountain phase trondjhemite of Bysouth *et al.* (1995).

Exposures of the unit are buff-white weathering, leucocratic, and coarse (3-4mm) to very coarse-grained (7-10mm). Quartz content ranges from 30 to 65%, with a clear prevalence of coarser-grained, quartz-rich end members to the northeast. Mafic minerals are typically well chloritized and comprise from 5 to 15% of the unit. Secondary, fine to medium-grained, disseminated, pistachio-green epidote comprising from 2 to 5% is a distinctive feature that is commonly accentuated on weathered surfaces.

The structural character of the unit is variable, similar in many respects to that of the leucocratic quartz diorite (EJGqdl) ranging from massive to well foliated with local discrete high strain recrystalized shear zones. The equigranular coarse-grained phase along the southern contact with EJGss is strongly foliated and contains from trace to 5% sericite across a distance of 1 to 2 kilometres parallel to the contact.

LATE LEUCOCRATIC TONALITE

This is a volumetrically minor phase of the Granite Mountain batholith and not illustrated in Figure 3. Although a minor phase, it has been given particular significance relative to the genesis of the Gibraltar mineralization by some previous workers (Drummond *et al.*, 1976; Bysouth *et al.*, 1995) and warrants discussion.

It was referred to as the quartz feldspar porphyry by Simpson (1970). Eastwood (1970) subdivided the unit into two types, which were termed the porphyritic facies and the quartz-eye facies. Drummond *et al.* (1973) also distinguished two distinct phases, which he termed the leucocratic porphyritic quartz diorite and the quartz feldspar porphyry. The unit was later collectively referred to as the leucocratic phase by Sutherland Brown (1974), Drummond *et al.* (1976), and Bysouth *et al.* (1995).

It constitutes a very distinctive white tonalite containing virtually no mafic minerals, and is clearly late in the magmatic history of the batholith. Consisting primarily of both quartz (35-40%) and saussuritized feldspar (60-65%), it ranges from coarse-grained equigranular to quartz-feldspar porphyritic. Contacts within drill core have been reported as being both intrusive and gradational in character. The unit is well exposed along the north wall of the Pollyanna pit as a series of 2 to 4 metre wide dikes that dip moderately to the north northwest. Margins are generally sharp and planar but locally contrasting white tongues of the late leucocratic tonalite finger into the darker host intrusive.

Initial description of the unit resulted from its observation in several drill hole intersections on the Pollyanna and Gibraltar East mineralized zones prior to mining (Simpson, 1970; Eastwood, 1970). Information regarding the number of drill holes, or over what intervals the unit was intersected were not provided. It was first suggested by Drummond *et al.* (1973) that the presence of these rocks was suggestive of a felsic core, central to the Gibraltar East, Granite Lake and Pollyanna ore bodies. This central core was subsequently indicated by Sutherland Brown (1974) and Drummond *et al.* (1976) to form a tear drop shaped body. These authors indicate however, that the body was not well constrained and its outline was considered tentative. The unit does not appear on the local geology map of Bysouth *et al.* (1995). Pit mapping, planned for 1999 will help to further constrain the limits and distribution of the unit.

BORDER PHASE QUARTZ DIORITE (EJGb)

This phase is most prevalent along the northeastern margin of the batholith, where it is distinguished by a pronounced textural variability. It is largely a medium-grained quartz diorite but locally contains patchy areas of coarse and fine-grained varieties. It is clearly distinguished from the more leucocratic and coarser-grained tonalite phase. Xenoliths of fine grained feldspar phyric quartz diorite, considered to be of cognate origin, as well as angular clasts of epidote-altered, green-gray, fine-grained volcanic rocks are also evident. Fine-grained, leucocratic dioritic dikes, 1 to 2 metres in width intrude the volcanic rocks near the contact between the two units.

Some previous workers applied the term "border phase" as noted above to the southern melanocratic quartz diorite unit. We use the term in a similar fashion to characterize the marginal intrusive contact phase but apply it to a distinctly different phase of the batholith. This unit is in part equivalent to the northern border phase of Panteleyev (1977).

It was previously interpreted to be at least in part, a younger intrusion referred to as the Burgess Creek stock (Panteleyev, 1977; Bysouth *et al.*, 1995). This

may have been in part to address the fact that the unit intrudes the volcanic rocks, which were previously considered younger than the Granite Mountain Batholith. The character and reinterpretation of these volcanic rocks with respect to their inferred age and regional correlation is given below.

CHLORITE-SERICITE-QUARTZ-FELDSPAR SCHISTS (EJGcs)

Chlorite-sericite-quartz-feldspar schists are interpreted as intensely deformed and recrystalized mafic phases of the Granite Mountain batholith. The rocks form a distinctive metamorphic unit that outcrops as two broad bands. A northern band, which outcrops along Cuisson and Ross Lakes and continues east along the central portion of the map sheet, was mapped previously. The unit along the southern margin of the pluton is newly recognized. The northern belt was previously interpreted to be deformed and metamorphosed Cache Creek rocks. However, transitions from milled, to mylonitic, to completely schistose phases of the dioritic and quartz dioritic rocks are clearly discernible throughout the unit. The mafic-rich character of the protolith is demonstrated by the presence of medium to coarse-grained, hornblende-rich diorite and local hornblendite near the melanocratic quartz diorite within relatively low strain zones. No exposures of metamorphosed Cache Creek sedimentary or volcanic rocks were identified within this belt.

A wide variety of hydrothermal vein types are recognized throughout this unit. They range from being sub-parallel with the prominent foliation to totally discordant. Vein types include quartz, quartz-chlorite, iron-rich carbonate and epidote which may occur individually or as combinations of all of the above. Veining is much more prevalent along the northern belt of chlorite-sericite schists (unit EJGcs). No significant veining was noted within limited exposures of the unit to the south.

Eastwood (1970) reported that winter drilling through the ice on Souran Lake cut granitic rocks under most of the lake and intersected possible equivalent metamorphic rocks under the southwest end of the lake. In addition drilling just north of Cuisson Lake by Imperial Oil in 1970 on the G property (MINFILE 093B015) crossed a contact between foliated quartz diorite and chlorite schists. The drilling information suggests that the belt of metamorphosed diorite continues northwest along Cuisson Valley which is consistent with the regional metamorphic fabric.

TAKLA-NICOLA (?) VOLCANICS

Volcaniclastic rocks are pale gray-green fine to medium-grained tuffs and matrix-supported lapilli tuff breccias. Lapilli generally comprise from several to 15%, and locally 25% of the unit. They include both volcanic and medium-grained quartz-dioritic clasts, usually ranging from half a centimetre to several centimetres in size, but clasts from 6 to 10 cm are not uncommon. Intervals from less than a metre to several metres thick of gray to pale-gray, tuffaceous limy mudstones are common throughout the sequence.

Sedimentary rocks are dominantly laminated mudstone-siltstone with lesser massive, medium-grained volcanic sandstone. The extent of the unit as indicated in Figure 3 is constrained largely by drill hole information from Gibraltar Mines (Ash *et al.*, 1999).

The sequence shows clear evidence of inhomogeneous ductile deformation, under similar metamorphic conditions to those within the Granite Mountain Batholith. Outcrops range from relatively massive and undeformed to strongly foliated with local mylonitic zones as well as discrete schistose bands from less than ten up to several tens of centimetres in width within the deformed zones. In the volcanic breccia unit augening of lapilli produces a well-defined flattening fabric and schistose zones in both the volcanic and sedimentary rocks are locally crenulated.

The most intensely deformed and recrystalized volcanic and sedimentary rocks crop out immediately north of the batholith. To the northeast the deformed zones are more localized. Within the volcaniclastic sequence in many cases the bulk of the strain is preferentially taken up by the limy intervals. These commonly display a well-developed penetrative foliation, which is locally crenulated, while volcanic breccias and tuffs above and below these deformed intervals are relatively massive. Foliation and related shear fabrics most commonly dip steeply to the northeast, and hinges of minor folds plunge at shallow angles to the southeast.

No fossils have been identified from the volcanic sequence to provide any stratigraphic age constraints. Its relative age is currently constrained by the intrusion of dikes interpreted to be correlative with the Granite Mountain Batholith into the sequence. This implies that the unit is either older than or roughly coeval with the age of the batholith. The presence of fine and medium-grained quartz diorite as lapilli sized clasts within in the volcanic breccias supports a co-genetic relationship between the batholith and the volcanic rocks. Both units display similar structural features suggesting that both have been affected by the same regional tectonic event. Based on observed field relationships this

volcano-sedimentary succession is now considered correlative with the late Triassic to lower Jurassic Nicola-Takla volcanic assemblages exposed east of the current map area.

STRUCTURE

The structural character of the deformed intrusive rocks have been previously described (Eastwood, 1970; Simpson, 1970). Southerland Brown (1974) and Drummond (1976) presented detailed analysis of foliation and mineralized vein structures within both the Gibraltar East and Granite Lake Pits. Detailed analysis of structural data collected in 1998 has not been attempted; however, discussion of the broader scaled structural features is possible.

The attitude of the regional foliation fabric outlines a uniform systematic pattern suggesting that the intrusion forms a large-scale anticline which plunges gently to the southeast. Foliation fabrics in the northwestern portion of the batholith generally dip at moderate to shallow angles to the southwest. Local variation in dip of the foliation to the northeast results from areas of broad open folding with amplitudes on the 500 metre plus scale. Eastwood (1970) reported that detailed mapping in the Pollyanna zone by Duval Corporation indicated the foliation is thrown into broad open folds. Detailed pit mapping in 1998 confirmed that broad open folding of the schistosity cleavage and related shear zones are a characteristic feature of the deposit. Towards the central and southern portion of the batholith the foliation gradually swings counter clockwise towards the west and dips at moderate angles to the south.

Minor fold hinge and crenulation lineation as well as intersection lineations between the folded schistosity (S_1) and related axial planar cleavage (S_2) generally best developed in the schistose units, consistently plunge at shallow angles to the southeast. Detailed structural mapping by Sutherland Brown (1974) of the Gibraltar East pit following the first year of mining documented that numerous minor folds throughout the pit have consistent plunge directions. A sterographic plot of this structural data indicates a fold axis maximum plunging at 18° degrees towards 149°. This orientation is also consistent with the general plunge of the Gibraltar ore bodies (G. Barker personal communication, 1998).

Late, high-angle northeast and northwest trending fault zones are evident as strong linears on colour contoured elevation and aeromagnetic maps and on radar imiages of the region. Occasionally these are identified in surface expressions, mainly within the batholith as one to several metres wide, rusty-brown, hematite stained zones of crushed and milled granitic rocks. Little information is available to determine the motion on these faults but they are considered significant in controlling the regional map pattern.

GIBRALTAR MINE

The Gibraltar Mine is a bulk tonnage, low-grade copper-molybdenum deposit concentrated along hydrothermally altered shear zones within the Granite Mountain Batholith along the west slope of Granite Mountain. It is one of the lowest grade base metal deposits ever mined in British Columbia. It is also the first in the province to have the majority of its initial production from supergene ore (Rotherham *et al.*, 1971). The mine has been in active production for the past 26 years, with mining operations ending on December 31st, 1998 due to depressed metal prices. From start up in March 1972 to recent closure, Gibraltar milled a total of 325 million tons of ore with an average Cu grade of 0.351% (Table 1).

TABLE 1
GIBRALTAR MINE PRODUCTION - 1972 TO DECEMBER 31, 1998

Production Statistics		
Pit	**Ore (tons x 1,000)**	**Cu (%)**
Gibraltar East Stage 1	34 311	0.453
Gibraltar Lake Stage 1	34 596	0.423
Pollyanna Stage 1	29 195	0.380
Gibraltar West	3 545	0.387
Gibraltar East Stage 2	57 337	0.351
Pollyanna Stage 2	28 447	0.292
Granite Lake Stage 2	26 597	0.324
Pollyanna Stage 3	30 374	0.313
Gibraltar East Stage 3	80 114	0.307
Pollyanna Stage 4	296	0.330
Total	324 812	0.315

tonnage in *short dry tons*

MINING HISTORY

Earliest recorded exploration activity in the Gibraltar area occurred in 1917. Periodic work continued up to the early 1960s when major mining companies became interested in the Granite Mountain area. In 1970, after extensive exploration work and property acquisition, Canex Placer Ltd. (now Placer Dome Inc.) made a production decision and the first ore was milled in March 1972. Detailed overviews of the earlier exploration activity on the property have been given previously (Eastwood, 1970; Sutherland Brown, 1974; Bysouth *et al.*, 1995). Here we review the more

recent activity at Gibraltar. In July 1993, Placer Dome Inc. reduced their interest in Gibraltar Mines Ltd. to 44.4%. A new independent management team was formed and began to develop properties in North and South America. On October 12, 1996, Placer Dome Inc. finalized the sale of their remaining 30.8% interest in Gibraltar Mines Ltd. to Westmin Resources Ltd. By December 1996, Westmin Resources Ltd. succeeded in obtaining 100% ownership of Gibraltar Mines Ltd. A takeover bid was initiated by Boliden Ltd. in December 1997 and by March 1998 they had completed the acquisition and formed Boliden Westmin (Canada) Ltd., a wholly owned subsidiary of Boliden Ltd. Subsequently, a decision was made to close the Gibraltar Mine and production ceased in December 1998.

EXPLORATION

GIBRALTAR MINES: Since the start-up of the Gibraltar Mine in 1972, exploration has added 400 million tons at 0.285% total Cu to the mineral resource; 105 million tons at 0.305% total Cu and 0.010% Mo to the sulfide ore reserve and 16 million tons at 0.213% total Cu and 0.160% acid soluble Cu to the oxide ore reserve (Table 2).

TABLE 2
GIBRALTAR MINE RESERVES
AS OF DECEMBER 31, 1998

		Ore (tons)	Cu (%)	Mo (%)	Cutoff (% Cu)
Pollyanna	*proven*	34 283 200	0.317	0.010	0.20
	probable	1 977 300	0.285	0.008	0.20
	combined	36 260 500	0.315	0.010	0.20
Granite Lake	*proven*	70 691 000	0.322	0.009	0.20
	probable	6 942 000	0.321	0.007	0.20
	combined	77 633 000	0.322	0.009	0.20
PGEC (Pollyanna-Gib East conector)	*proven*	43 825 700	0.271	0.010	0.16
	probable	6 179 000	0.261	0.001	0.16
	combined	50 004 700	0.270	0.010	0.16
Total Reserves	*proven*	148 799 900	0.306	0.010	
	probable	15 098 300	0.292	0.009	
	combined	163 898 200	0.305	0.010	

tonnage in short dry tons

More recent exploration by Gibraltar has also been done on the GM claims located about 1 km northeast of the Pollyanna pit. Geochemical rock and soil surveys conducted on the claims in 1995 and 1997 located several Cu and Mo anomalies. In December 1997, an induced polarization (IP) geophysics survey outlined a large chargeability anomaly extending across the entire grid. During April 1998, five diamond holes (totaling 983 metres) were drilled on a strong IP anomaly. Mineralization was encountered in four of the drill holes with good molybdenum grades (average 0.030% MoS_2) and copper grades of 0.15% to 0.20% Cu in the primary zone and 0.30% Cu in the supergene enriched zone. Further diamond drilling is required to test the extent and grade of the GM mineralized zone and to test several other IP anomalies along the mineralized trend.

Exploration to date has not exhausted the potential of the Gibraltar property and a number of exploration targets remain untested. It is not unreasonable to expect that further exploration activity would reveal new mineralized zones and provide additional ore reserves.

UNITED GUNN RESOURCES LTD.: Compilation of prior exploration work in the Gibraltar region by Crest Geological Consultants Ltd. in 1997 outlined five priority exploration targets. During the fall of 1997 and early 1998, 411 claim units were staked in six separate claim blocks surrounding Gibraltar Mines claims on behalf of United Gunn Resources Ltd. During 1998, exploration work consisting of geological mapping and prospecting, grid work, soil sampling, magnetometer and VLF-EM surveys were completed over 160 kilometres of grid lines. This work outlined two zones of anomalous copper mineralization.

The first zone, referred to as the Bysouth Showing outcrops on the Copper Ace North Grid situated roughly 10 kilometres northwest of the Gibraltar Mine (Figure 2). Mineralization consists of medium to coarse-grained disseminated chalcopyrite and pyrite with malachite and azurite in a silica-rich breccia zone. Angular rock fragments up to 15cm in size consist of chlorite-sericite altered quartz diorite possibly part of EJGqdm or mine phase equivalent quartz diorite EJGss. Other fragments consist of quartz+/-feldspar porphyry and quartz. All fragments are set in a vuggy quartz rich matrix. Both rock fragments and matrix contain mineralization. The breccia zone is up to 125 metres wide and has been traced by magnetics and IP resistively/chargeability response along strike to the northwest for some 1325 metres. The structure remains open to the northwest and southeast. Rock grab samples from outcrop of the mineralized quartz breccia contain up to 7.2% copper.

The second anomalous zone referred to as the Rick Showing outcrops on the Copper Ace South grid located 1.5 kilometres northwest of the Gibraltar Mine plant site (Figure 2). Prospecting in this area yielded significant disseminated copper mineralization in altered mine phase quartz diorite (EJGSS). Assay values

up to 1.5% copper and 1.1% zinc are common throughout the area. IP surveying defined a chargeability anomaly (3-5 times background) 150m-200m wide which extends to the northwest some 500m. This chargeability anomaly remains open to the northwest and southeast. Further to the west is an intense, partially defined chargeability anomaly (5-8 times background) that remains open to the northwest, southeast and west.

Diamond drilling totaling 3000 metres in 10 holes to evaluate the extend of mineralization along strike is planned for both areas during the 1999 field season.

The discovery of significant copper and zinc mineralization outside of the Gibraltar Mine claims area by United Gunn Resources Ltd. suggest that significant discoveries will require a concerted and persistent effort.

MINERALIZATION

The following description of mineralization relies heavily on the work of Simpson (1970) whose observations were made in consultation with Canex-Duval geologists and supplemented by detailed petrographic work on core samples. Core sections of the mined ore bodies from this and subsequent periods of drilling are not available for observation. Several days of detailed pit mapping that included observations at the Gibraltar East, Gibraltar West and Pollyanna were conducted in 1998. Completion of detailed pit mapping to provide a cross-section through the mine is planned for 1999. Additional observations from Eastwood (1970), Drummond *et al.* (1973,1976), Sutherland Brown (1959, 1974) and Bysouth *et al.* (1995) are incorporated into this description.

Copper-molybdenum mineralized rocks at Gibraltar have been mined from four open pits, the Gibraltar East, Gibraltar West, Granite Lake and Pollyanna (Figures 4). The ore bodies mined form part of a semi-continuous, anastomosing mineralized shear zone up to 100 metres or more in thickness, that parallels the strike of the regional foliation. The shear zone and associated mineralization are affected by broad open folding and display a geometry similar to that described previously for the regional foliation. Sulphide mineralization develops within or marginal to the more schistose zones, and fades out into the more massive, less foliated quartz diorite, with mineralization confined largely to the foliation surfaces and narrow mineralized veinlets (Simpson, 1970). The best mineralization is found towards the center of the mineralized belt of schistose rocks. The main ore minerals are chalcopyrite, chalcocite (supergene) and molybdenite. Pyrite is common in both ore and peripheral alteration zones and also forms an extensive halo with a few percent pyrite that envelopes the mineralized shear.

The fine-grained copper mineralization that constitutes the uniform, well distributed grade at Gibraltar (Bysouth *et al.*, 1995) is contained within thin quartz-sericite-chlorite veinlets, 1 to 2 millimetres wide (V_1 veins of Sutherland Brown, 1974) that occupy 1 to 4 centimetre spaced schistosity cleavage planes. Spacing between these planes becomes progressively closer on approach to schistose zones. Paralleling quartz-sulphide shear hosted veins (V_2 veins of Sutherland Brown, 1974) occur at 3 to 5 metre intervals. These are from several centimetres to several tens of centimetres wide and have envelopes of sericite schist from 2 to 10 centimetres wide, the width increasing relative to the size of the quartz-sulphide veins.

Simpson (1970) noted that minor molybdenite is widespread; its abundance is roughly proportional to the amount of chalcopyrite. It occurs as fine smears along chlorite foliation planes similar to the occurrence of chalcopyrite and as fine disseminations in quartz veinlets. Southerland Brown (1974) recognized that molybdenite was also common in ribboned quartz veins. These veins he termed V_3, which like V_2 are shear hosted, foliation parallel major veins with sericitic envelopes and thought to be slightly later than V_2 veins. Later V_4 veins are irregular and usually at a high angle to the V_1, V_2 and V_3 veins. These consist of either quartz or quartz-chlorite with 1 to 4 centimetre blebs of carbonate, chalcopyrite and lesser pyrite and are usually several tens of centimetres in width but lack continuity.

Magnetite is indicated to be present everywhere in minor amounts (<1%, Bysouth *et al.*, 1995) and the overall magnetic expression of the mineralized zones and Granite Mountain Batholith in general, are subdued on regional aeromagnetic maps.

Simpson (1970) recognized that sphalerite was readily identified within the most northwesterly mineralized zones and that bornite was restricted to the eastern limits of the known deposits. Drummon et al., 1973, 1976) presented a detailed metal zonation model for mineralization centered on the Granite Lake and Pollyanna ore bodies. A low sulphide core with chalcopyrite, bornite and minor pyrite passes outward into a interval where chalcopyrite and pyrite are present in equal amounts. This is fringed by a zone where pyrite becomes more abundant with chalcopyrite occurring only in trace amounts. Subsequently, Bysouth *et al.* (1995) introduced a hydrothermal metal zonation model for Gibraltar. It was suggested that metals were deposited along a geothermal gradient in a

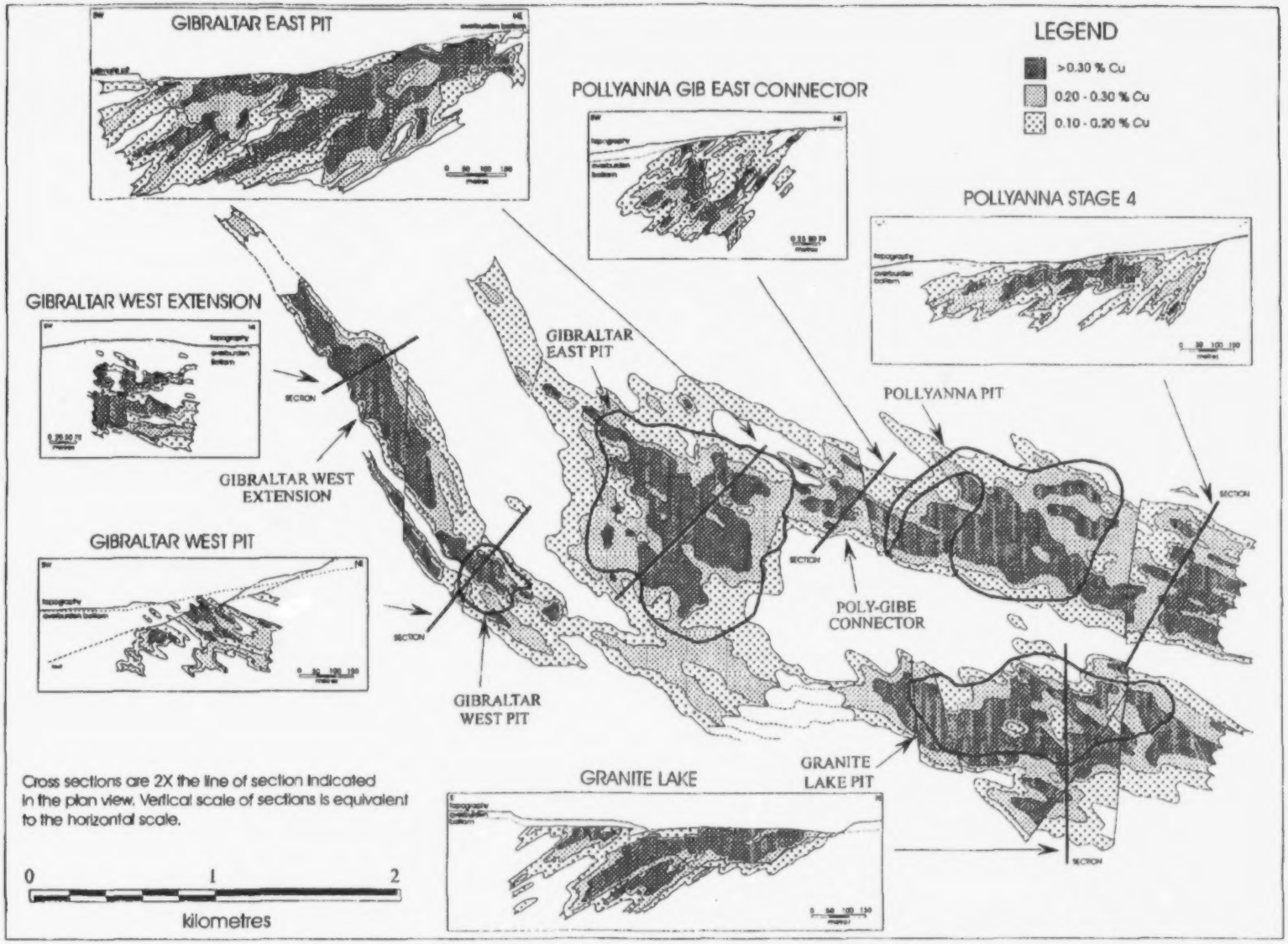

Figure 4. Copper isopleth map and cross-sections of Gibraltar mineralization. Location of mineralized zone indicated on Figure 3. (Data obtained from Gibraltar Mines).

sequence from higher to lower temperature of chalcopyrite + molybdenite, to chalcopyrite, to chalcopyrite + sphalerite. As noted by Simpson (1970) and Bysouth (1995) zonation patterns are based on general field observations and have not been systematically studied. Clearly such a study is necessary to accurately characterize the variation in metal character for Gibraltar.

Hydrothermal assemblages associated with mineralization consist of sericite, quartz, chlorite, minor dolomite and pyrite. Simpson (1970) studied alteration mineralogy across the mineralized zones from drill core samples from both Gibraltar East and Pollyanna. He found that the degree of sericite enrichment (K-metasomatism) is proportional to the copper content where grades were greater than 0.15%. Characteristics of both chlorite and epidote were also studied petrographically. Fe/Mg ratios in chlorite showed no compositional variation irrespective of copper grade. Similarly there was no correlation between the extent of epidote alteration and grade, suggesting that both these minerals are primarily of metamorphic origin. K-feldspar or biotite have not been recognized as alteration minerals at the Gibraltar mine (Bysouth *et al.*, 1995).

DISCUSSION

Various hypotheses for the genesis of mineralization at Gibraltar have been proposed. Initial showings on the property, such as the Pollyanna and Sunset (now Gibraltar West) were characterized as mineralized shear zones (Eastwood, 1970). Sutherland Brown (1974) indicates that visiting European geologists during the years of intensive exploration viewed it as a stratiform deposit that had been deformed and metamorphosed. Simpson (1970) appears to be the first to compare some features of Gibraltar to those of "porphyry" copper deposits of the American southwest.

Drummond *et al.* (1973) were possibly the first to characterize Gibraltar as a porphyry deposit. They introduced a model in which the late leucocratic porphyritic tonalite phase was interpreted to be the late magmatic phase and the source of the mineralizing fluids. This late phase was suggested to form a core intrusive zone, which is fringed by an elliptically shaped sulphide bearing stockwork. The model implied that this late phase of the intrusion postdated the deformation and the mineralization was imposed on the pre-existing foliation fabric. This model was further advanced by Sutherland Brown (1974) and Drummond *et al.* (1976) who postulated that the felsic core zone was the centre of a zoned intrusion. They also recognized that the mineralization was synchronous with the regional metamorphic and cataclastic deformational event. Bysouth *et al.* (1995) proposed a tectonic model to explain intrusion of the Granite Mountain Batholith into the Cache Creek terrane which accounted for development of porphyry mineralization as previously advocated by Drummond *et al.* (1976).

Some of the most obvious features of Gibraltar, such as its grade and tonnage, metal signature, and the fact that it is hosted within an arc-volcanic pluton would all suggest that it is a porphyry deposit. However, the relative timing between magmatism and the mineralization is the most critical feature in characterizing this deposit as a porphyry. Designation as such implies that magmatism associated with the host intrusion was directly related to mineralization. In the case of Gibraltar however, the immediate relationship is complicated by the obvious structural control of the mineralization, which is part of a major regional deformational event, an event characterized by well-developed cataclastic and mylonitic shear fabrics.

All previous workers at Gibraltar recognized that the regional foliation fabric and related prominent schistosity cleavage which host the bulk of the ore existed either prior to, or was synchronous with mineralization. It was this feature that caused proponents of Gibraltar as a "porphyry deposit" to characterize it as '*a porphyry with a difference*' (Sutherland Brown, 1974) or as a "unique porphyry" (Drummond *et al.*, 1976; Bysouth *et al.*, 1995). To account for this relationship between the timing of regional fabric development and mineralization, and still maintain a genetic association with magmatism, porphyry proponents suggested that the foliation and related schiosity cleavage was formed during intrusion, differentiation and crystallization of the batholith and were in place before the late differentiated, inferred mineralizing phase was intruded. To suggest that the cataclastic and mylonitic shear fabrics characteized by retrograde greenschist grade metamorphic assembages occurred during crystallization of a magma body is difficult to rationalize.

A preferred interpretation, which accounts for the development of these metamorphic rocks and the coincident regional tectonic cataclastic fabric that overprints the batholith and surrounding lithologies, is that the batholith was structurally emplaced onto Cache Creek rocks and did not intrude them as previously interpreted. Reinterpretation of the protolith of the chlorite schist unit to the south of the mine area (unit EJGcs on Figure 3) as a deformed, metamorphosed and recrystallized, relatively mafic, dioritic part of the batholith, combined with recognition of a similar unit at

the southern limits of the intrusion rules out previous evidence for an intrusive relationship. Cache Creek rocks mapped in the immediate area of the batholith show no evidence of diking or hornfelsing by the batholith.

If, as we suggest, these fabrics result from tectonic emplacement of the batholith onto Cache Creek, it would imply that mineralization formed some 20 to 30 million years after magmatism, during accretion of the arc-complex to the continental margin, in this case mineralization would be unrelated to formation of the Granite Mountain batholith. The possibility that a pre-existing porphyry style of mineralization was remobilized during deformation can not be ruled out. However, no evidence has been identified to date to support this possibility.

Clearly, constraining the age of mineralization is key to resolving possible genetic models for the genesis of Gibraltar mineralization. Isotopic age dating by ^{39}Ar-^{40}Ar analysis of hydrothermal sericite associated with copper mineralization will help constrain these possibilities. Samples of sericite associated with mineralization as well as samples containing sericite from the central belt of chlorite schists in addition to a sample of mariposite in ankerite altered mafic volcanic rocks from Cache Creek are being analyzed by P. Reynolds at Dalhousie University, Halifax.

CONCLUSIONS

Mapping of the Gibraltar Mine region has identified relationships that significantly change previous interpretations of the regional geological setting of the Gibraltar mine region.

- Recognition that the central belt of chlorite schists represents a metamorphosed mafic-rich dioritic phase of the batholith, and not metamorphosed Cache Creek rocks eliminates previously presented evidence to suggest that the batholith intrudes Cache Creek terrane. Current data suggests that the contact relationship between the intrusion and the Cache Creek is structural.
- Volcanic arc rocks to the north and north east of the batholith are interpreted to be coeval and possibly co-genetic with the Granite Mountain Batholith. Volcaniclastic rocks are cut by dikes and also contain clasts which are similar in composition to the Granite Mountain batholith. Intrusive and volcanic display similar styles and orientations of cataclastic shear fabrics, suggesting a similar structural history.
- If a "porphyry deposit" is regarded simply as large, low-grade bulk tonnage mineralization, Gibraltar without question, is one. If, however, a "porphyry deposit" implies a genetic relationship between the mineralization and the magmatism of the hosting intrusive rocks then its designation as a porphyry is less certain.
- The high grade Cu and Mo mineralization at Gibraltar has previously been shown to be associated with intensely foliated to schistose rocks. These were initially interpreted as mineralized shear zones, but more recently have been considered as porphyry deposits with unusual structural features. Initial results of this study suggest more credence be given to the original interpretation. Further work is planned to constrain the genesis of Gibraltar mineralization.

ACKNOWLEDGMENTS

Kirk MacLennan provided enthusiastic and capable field assistance. We are indebted to George Barker and the staff of Gibraltar Mines Ltd. for sharing information and providing logistical support. Sarah Maxwell is thanked for producing the figures. Insights and contributions to mapping by Dave Lefebure, and Ron Smyth during field visits to the area were greatly appreciated. The contribution of Fabrice Cordey with the Université Claude Bernard, Lyon, France for processing and evaluating chert samples for radiolaria is greatly appreciated. Henry and Gerry Funk and staff of the Oasis Resort, McLeese Lake are thanked for their warm hospitality and logistical assistance. This report has been improved from discussions with and reviews by Dave Lefebure, Bill McMillan, Brian Grant, Joanne Nelson, Trygve Höy and Dorthe Jakobsen.

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TSACHA (093F 055)

By Jean M. Pautler[1], Scott W. Smith[1] and Robert A. Lane

LOCATION:	Lat. 53°02'N Long. 125°02'W (93F/3E) OMINECA MINING DIVISION. The property is located in the Naglico Hills area of the southern Nechako Plateau, approximately 125 kilometres southwest of Vanderhoof, British Columbia.
CLAIMS:	Tsacha, Tasha, Tasha 1 - 3 (84 units).
ACCESS:	South from Vanderhoof for 25 kilometres along the Kenney Dam road; south along the Kluskus-Ootsa forest service road to Kilometre 162; east along the 8000 road for 7.5 kilometres to the camp situated on the Tasha claim.
OWNER:	Teck Corporation (owner) signed a joint venture agreement with Corona Gold Corporation whereby the latter can earn a 50% interest in the property by spending $1.5 million by September, 2001.
OPERATOR:	Teck Exploration Ltd.
DEPOSIT TYPE:	Epithermal gold.
COMMODITIES:	Gold, silver.

EXPLORATION AND GEOLOGY OF THE TSACHA EPITHERMAL GOLD DEPOSIT

INTRODUCTION

The Tsacha epithermal gold deposit is an important recent discovery in the southern Nechako Plateau area of central British Columbia. The discovery of auriferous quartz vein mineralization in 1993 led to the identification of seven vein and/or stockwork zones on the property. All were located by prospecting. This report is an update of previous reports by Diakow and Webster (1994), Pautler (1994a, 1994b, 1995, 1996), Schroeter and Lane (1994), Lane and Schroeter (1995, 1997) and Smith (1997, 1998).

EXPLORATION HISTORY

The Tommy Lakes area has a brief exploration history. There is no record of exploration activity in the area prior to the discovery of auriferous quartz veins in 1993. During that year, a British Columbia Geological Survey Branch mapping crew discovered epithermal vein mineralization in the Naglico Hills area, south of Tommy Lake, while completing a 1:50 000-scale bedrock survey of the area (Diakow and Webster, 1994). Release of data to the public in January 1994, at the Cordilleran Roundup in Vancouver, led to a mini-staking rush of the area. Within a week after the release, three companies, Teck Corporation (Tsacha claim), Cogema Resources Inc. (Tam claim) and Phelps Dodge Corporation of Canada Limited (Taken 1 claim) had staked claims in the immediate area of the discovery. All three companies evaluated their respective claims during the next few years with the most encouraging assay results coming from Teck's Tsacha property.

In 1994 and 1995, prospecting, mapping and trenching by Teck on the Tsacha property identified a total of seven auriferous quartz vein and/or stockwork zones. Follow-up work in 1995 included the first diamond drilling on the property. Additional drilling in 1996 enabled Teck to complete a preliminary resource calculation for the main Tommy vein of 478 600 tonnes grading 8.72 g/t Au and 82.3 g/t Ag (using a 3 g/t Au cutoff).

In 1997, with Corona Gold Corporation as a joint venture partner, a drilling program focused on extending the vein system northward, but was unsuccessful. In 1998, deep drilling beneath a post-mineral microdiorite sill was successful in intersecting the Tommy and Larry veins.

Since 1995, more than 16 000 metres of diamond drilling in 81 holes has been completed, as well as trenching, soil geochemistry, an induced polarization survey, mapping and prospecting.

[1] Teck Exploration Ltd., 350 - 272 Victoria St., Kamloops, BC, V2C 2A2

GEOLOGY

REGIONAL SETTING

The Nechako Plateau is an area of subdued relief. Glacial drift is extensive and bedrock exposure is limited to between 5-10% of the area. The geology of the region was first mapped at a regional scale (1:250 000) by Tipper (1963). More detailed mapping of the southern Nechako Plateau was recently conducted by Green and Diakow (1993), Diakow and Webster (1994) and Diakow *et al.* (1993, 1994, 1995a, b, c). The recent mapping covers four 1:50 000 map areas, including the Fawnie Creek sheet (NTS 93F/3), from Nechako Reservoir southward to the Blackwater River (Figure 1).

The Fawnie Creek map area lies within the Stikine Terrane of the Intermontane Belt. It is situated near the southern margin of a northeast-trending, structurally raised area referred to as the Nechako uplift (Diakow and Webster, 1994). The uplift, bounded by the Natalkuz fault to the north and the Blackwater fault to the south, provides a window through younger cover to underlying volcanic and sedimentary rocks of the regionally extensive Lower to Middle Jurassic Hazelton Group and Late Jurassic Bowser Lake Group. These strata are intruded by the Late Cretaceous Capoose batholith, a granodiorite to quartz monzonite intrusion that has been unroofed in broad areas north and south of Entiako Spur. Eocene volcanic rocks of the Ootsa Lake and Endako groups are locally extensive. Isolated cappings of Miocene Chilcotin Group olivine basalt are rare within the uplift, but widespread to the south.

Rocks of the Hazelton Group predominate in the Naglico Hills and Tommy Lakes areas. The felsic volcanic dominated Entiako formation is overlain by the more extensive mafic volcanic succession of the Naglico formation (Diakow and Webster, 1994).

PROPERTY GEOLOGY

Much of the Tsacha property is underlain by rhyolitic and andesitic flows and tuffs of the Entiako formation (Figure 2). Basaltic andesite flows, with minor volcaniclastic interbeds, assigned to the Naglico formation, overlie the tuffs. An augite porphyry plug is exposed in the southern part of the property. The above units are intruded by Cretaceous microdiorite sills and dikes.

A moderately welded rhyolite ash-flow tuff (or ignimbrite) of the Entiako formation is the most extensive unit on the property and is host to mineralization (Photo 1). Petrographic studies indicate a quartz latite composition. The rock is magnetic when fresh, with an often glassy, dark grey to grey-green to maroon matrix and typically contains 5-10% quartz eyes and 15-40% feldspar phenocrysts. Up to 10% pale pink to buff-coloured, compressed pumice lapilli define a shallow (~10°) southerly dipping fabric that resembles flow banding. Less common subrounded clasts of dark green andesite are generally a few millimetres in diameter, but may be as much as 5 to 10 centimetres across. Welding is conspicuous south of Tommy Lake, but is rarely seen to the north.

Maroon dacitic to andesitic rocks exposed in sparse outcrops in the northeast part of the property are considered to be part of the Entiako formation. Similar volcaniclastic flows and tuffs, observed in drill core from the area, typically have a high hematite content and are comprised of 2-5% quartz and 20-45% feldspar as phenocryst phases.

Dark green feldspar and augite-phyric basaltic andesite flows of the Naglico formation conformably overlie the welded tuff in the southwestern part of the property. A medium-grained augite porphyry plug, exposed in the southern portion of the claims, is probably cogenetic with the flows. Minor volcanic-derived calcareous siltstone, sandstone and conglomerate, with abundant plagioclase grains and local argillaceous beds, crop out immediately north of the augite porphyry plug. They are derived primarily from the felsic volcanic rocks of the Entiako formation, but also contain clasts of augite porphyry.

Sills and dikes of microdiorite intrude the Jurassic rocks on the property and crosscut the epithermal vein system. South of Tommy Lake a microdiorite sill, 100 metres wide, has been mapped. Diamond drilling has shown that the sill typically ranges between 100 and 150 metres thick, has a shallow southerly dip (~10°), and is generally concordant with the gently south dipping pyroclastic volcanic rocks which it intrudes. A sample of the sill yielded a U-Pb zircon date of 73.8+2.9/-0.1 Ma, indicating latest Cretaceous emplacement (R.M. Friedman, personal communication, 1996). The microdiorite is fine grained, grey-green to brown, variably magnetic, blocky weathering and is characterized by minor vitreous biotite phenocrysts, calcite amygdules, and occasional plagioclase phenocrysts. A second microdiorite sill is exposed on a knoll south of the Tsacha grid. In this area, the microdiorite appears to grade into andesite dikes with calcite amygdules and minor augite phenocrysts.

STRUCTURE

The Tsacha property lies along a regional northwest-trending lineament that locally follows Tommy Creek. This lineament may have economic significance in that it passes through the Wolf and Clisbako epithermal gold prospects to the northwest and southeast, respectively (see Diakow and Webster, 1994). It is most evident on the airborne magnetic map of the Interior Plateau (Geophysical Data Centre, 1994).

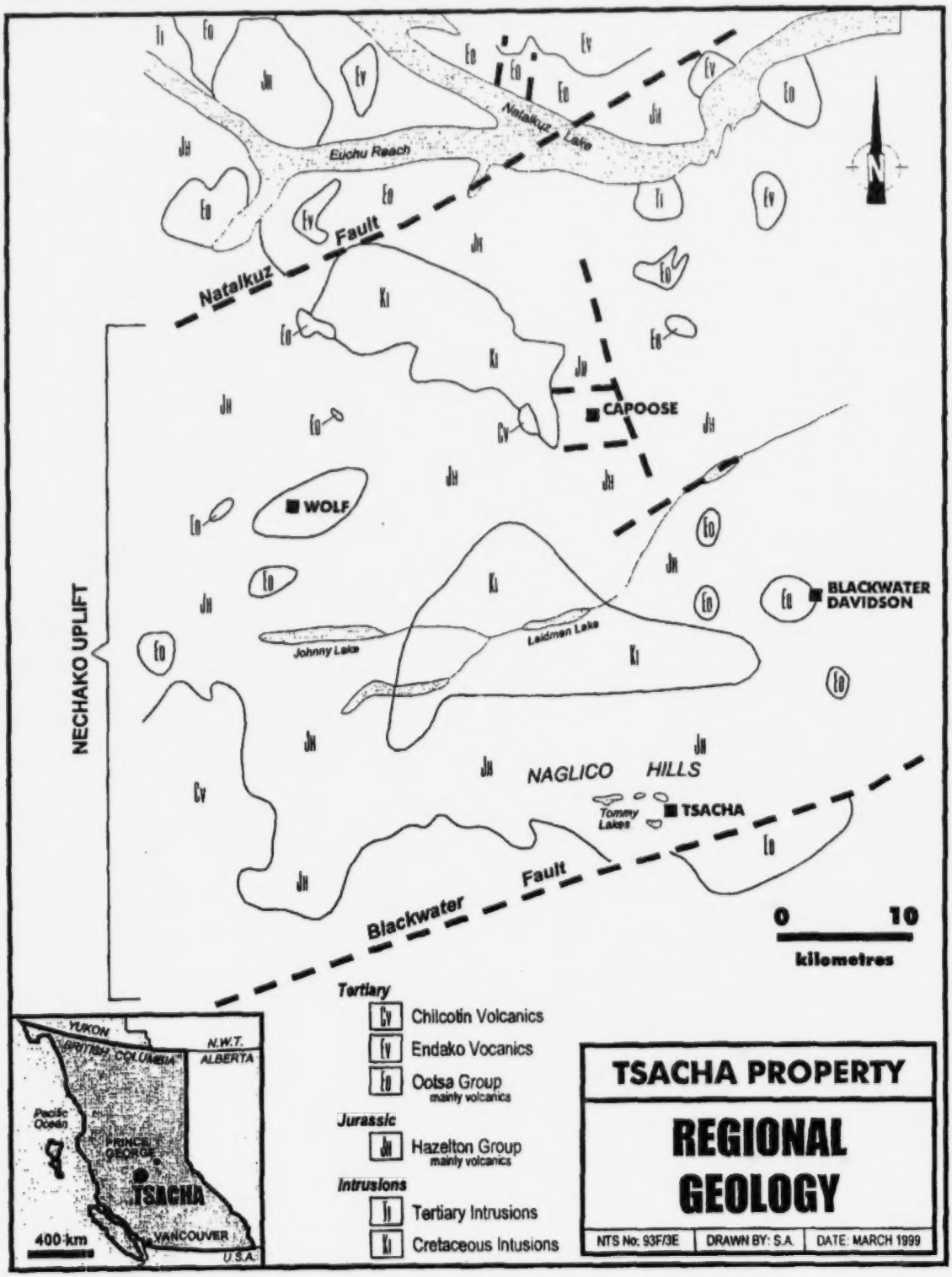

Figure 1. Location of the Tsacha property and regional geology of the southern Nechako Plateau (after Diakow *et al.*, 1993, 1994).

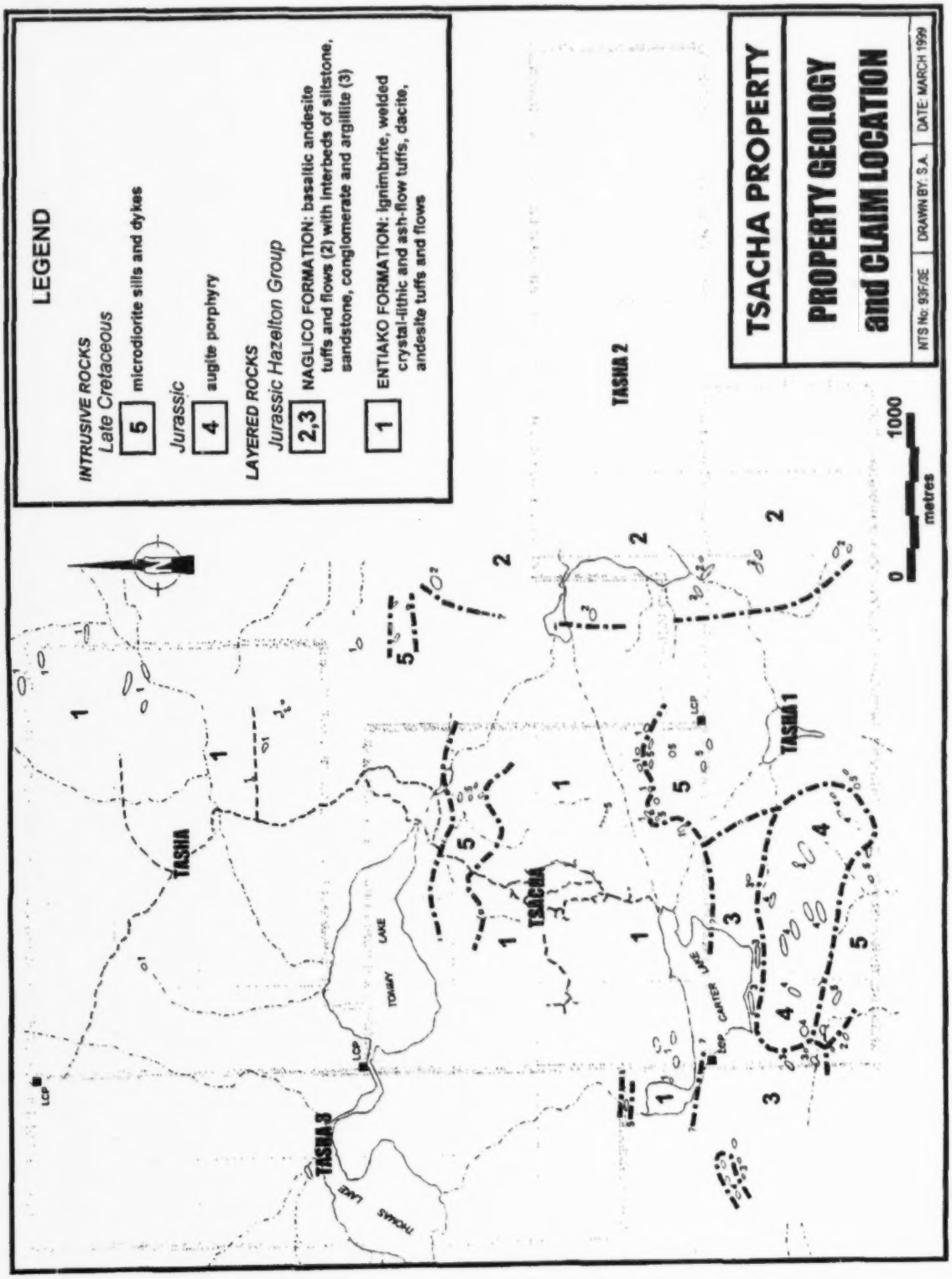

Figure 2. Property geology and claim locations for the Tsacha, Tasha and Tasha 1 - 3 claims.

Photo 1. Maroon welded ash-flow tuff (ignimbrite) of the Entiako formation.

The southern boundary of the Nechako uplift follows the Blackwater River, just south of the property. Similar east-northeasterly trends are evident on the property, through Carter Lake and north of Tommy Lake, and are best observed on 1:15 000-scale aerial photographs. Northerly trends are less evident, but are manifest as north-striking epithermal quartz veins on the property. Throughout the region, north-trending structures are believed to be related to Tertiary extension. However, the presence of pre-existing north-trending structures is confirmed by the pre-Late Cretaceous Tsacha vein system.

Numerous post-mineral faults have been identified. Faults truncate the southern strike continuity of the Tommy vein, but the direction and amount of offset has not been confirmed. However, the Tam 3 claim, that adjoins the Tsacha property to the east, hosts two prospective epithermal quartz veins known as the Ted and Mint showings (Fox, 1996). It is postulated that these quartz veins are the southern continuation of the Tsacha epithermal vein system and have been displaced eastward along an east-northeast-trending fault some 1200 metres. Deep drilling, completed in 1998, intersected the Tommy and Larry veins beneath the sill approximately where expected. This suggests that there is little or no offset of the vein system in an east-west direction along the plane of the sill.

ALTERATION

Pervasive, secondary, earthy hematite and minor specularite are widespread on the property. Volcaniclastic rocks of the Entiako formation, and in particular non-welded units north of Tommy Lake, are most visibly affected and range in colour from pale maroon to dark red-brown. Clay and sericite alteration is variable, but well developed in association with faults that cut the veins (*i.e.* at the south end of the Tommy vein and accompanying the Ian stockwork.). The veins generally have narrow alteration envelopes consisting mainly of intense silicification.

MINERALIZATION

A total of seven significant veins, three vein-stockwork zones and two silicified zones have been discovered on the property to date. They include the Tommy, Larry, Bobby, Billy, Johnny, Alf and Barney veins and the Ian, Larry and Goofy stockwork zones (Figure 3). They occur over a width of approximately

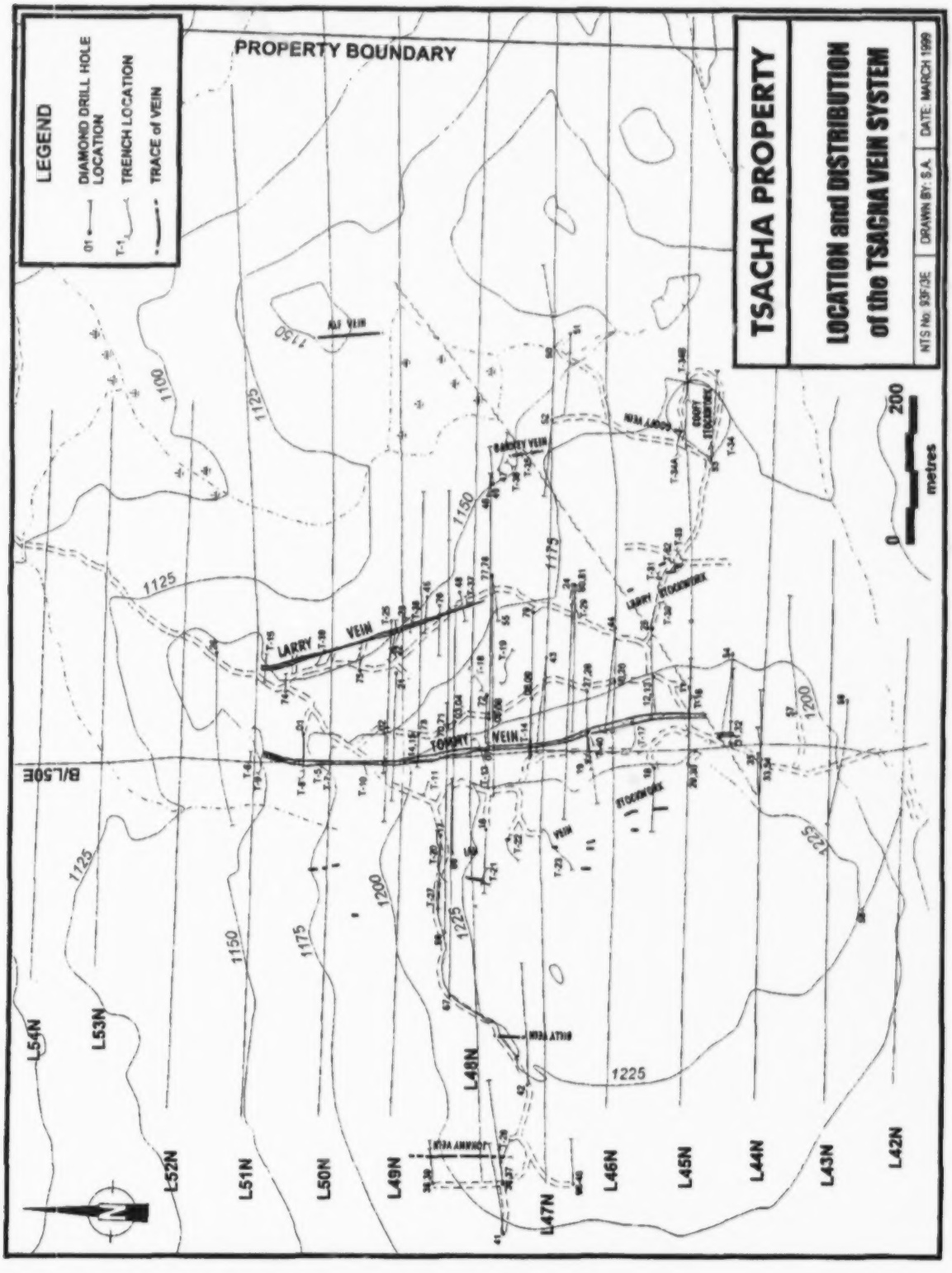

Figure 3. Location and distribution of the Tsacha vein system, central Tsacha claim..

1000 metres, have trends that range from 150° to 180° and dip steeply west to subvertical. Hostrock for the vein and stockwork zones is the welded rhyolite ash-flow tuff of the Entiako formation. The Tommy and Larry veins are discussed below.

The Tommy vein (Photo 2) is the most prominent discovered to date and has been the focus of exploration on the property. It has a 170° to 180° trend, is subvertical, averages 3 to 4 metres in thickness and has been traced along strike for 640 metres above the sill. The vein zone is comprised of one or more discrete veins, separated by quartz stockwork zones and/or intensely silicified wallrock. It consists primarily of massive bull quartz grading to chalcedonic quartz, locally with sparry calcite, pale grey, banded chalcedony, hematite and rare amythest. Classic epithermal textures are common and include drusy cavities and colloform bands (Photo 3). Fractured to brecciated zones are healed by quartz and later stage calcite. Increasing calcite content appears to correlate with lower gold grades. Vein margins are generally quite sharp, but may be gradational where intense silicification and stockwork zones are well developed. Parallel veinlets may extend up to 5 metres into the wallrock. The vein has excellent continuity along strike, but its width varies significantly over short distances.

Visible sulphides are generally sparse, but traces of pyrite, rare galena and chalcopyrite are generally associated with brecciated veins and stockwork zones. Native gold, electrum, stephanite and argentite have been identified in thin sections of grey banded chalcedony from the Tommy vein (Pautler, 1994b and Wells, 1995).

Deep diamond drilling in 1998 traced the Tommy vein along strike, below the sill, for over 170 metres, and down dip for over 100 metres. The true width of the sub-sill vein intersections ranges from 0.7 to 9.35 metres, the thickest vein intersection to date. The last hole drilled in 1998, T98-81, intersected the Tommy vein below the sill and returned values of 3.13 g/t Au over a true width of 9.35 metres, including 8.88 g/t Au over a true width of 1.4 metres. Although the gold assays, both above and below the sill, are fairly consistent (generally ranging from 1 to 10 g/t Au), there are higher grade intersections that suggest the existence of ore shoots and/or feeder structures.

Photo 2. Exposure of the Tommy vein on knoll south of Tommy Lake.

Photo 3. Grey and white colloform-banded chalcedony from the Tommy vein.

The Larry vein crops out approximately 135 metres east of the Tommy vein and has been traced along strike for over 300 metres. It ranges up to 5.1 metres wide, but is typically 0.5-1.5 metres across. Three holes drilled in 1998 intersected the Larry vein beneath the sill. They define a minimum 50-metre strike length and 100-metre down-dip extension for the sub-sill portion of the Larry vein. The best intersection assayed 6.9 g/t Au over a true width of 1.6 metres. Previous drilling (above the sill) yielded assays up to 6.8 g/t Au over 3.8 metres, including 8.4 g/t Au over 2.5 metres.

The Larry vein, as well as the other veins on the property, is very similar to the Tommy vein in gangue mineralogy and texture. Vein widths and grades vary widely.

DISCUSSION

During 1994-1998 Teck Exploration (operator) completed prospecting, mapping, geophysical surveying (primarily IP), trenching and diamond drilling on the Tsacha epithermal gold vein system. Teck's work identified seven auriferous veins and additional stockwork and silicified zones.

In 1997 the company released a preliminary drill-indicated resource for the main Tommy vein (above a crosscutting microdiorite sill) of 478 600 tonnes grading 8.72 g/t Au and 82.3 g/t Ag using a 3 g/t Au cutoff. The resource calculation was based on 27 drill and 9 trench intersections. Deep drilling beneath the microdiorite sill was successful in intersecting both the Tommy and Larry veins. Both veins are open along strike to the north and south, as well as at depth.

The Tommy vein has returned a range of gold assays; when plotted on a longitudinal section (Figure 4), they strongly suggest the existence of a central higher grade core and possible ore shoots and/or feeder structures. Significant assays from four sub-sill intersections indicate the potential for additional reserves.

The Larry vein is more structurally complex. It may not be as continuous along strike, but more drilling is required to properly test this structure. Detailed evaluation of the Larry vein may lead to a further increase in the preliminary resource estimate for the property.

In conclusion, the potential for discovery of additional epithermal gold veins is considered excellent. More deep drilling, or an underground program, will be required to thoroughly explore the Tsacha vein system beneath the sill.

ACKNOWLEDGMENTS

Data presented in this paper are the result of exploration completed by the two senior authors and information gathered by the third author during the course of numerous visits to the property. Stephen Archibald, Teck Exploration Ltd., kindly drafted the figures. A review of an earlier draft of this report by John Newell is much appreciated.

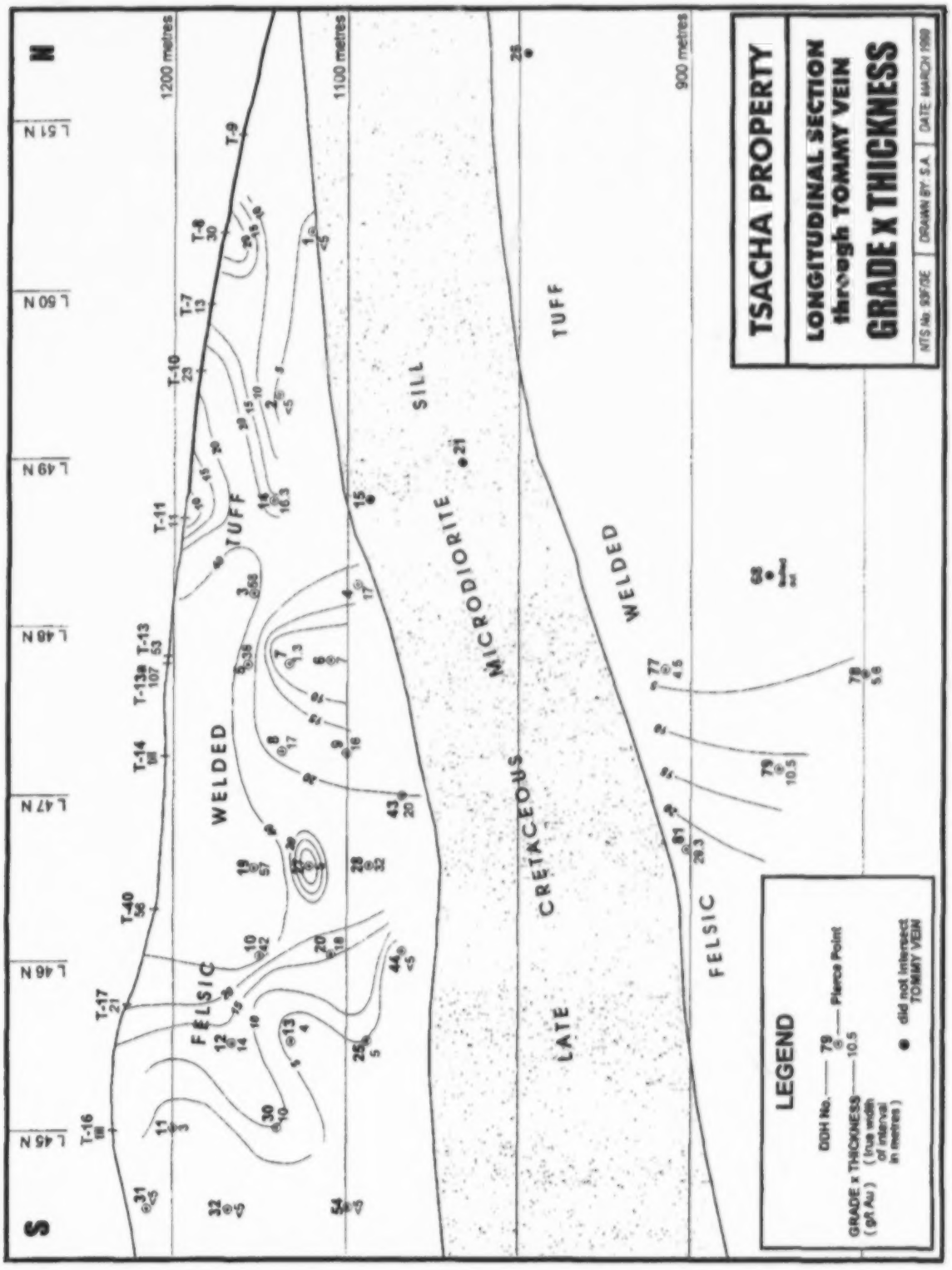

Figure 4. Longitudinal section of the Tommy vein showing grade x thickness contours.

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VOLCANOGENIC MASSIVE SULPHIDE DEPOSITS IN THE HAZELTON GROUP, BABINE RANGE, B.C.

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INTRODUCTION

There are a number of polymetallic mineral showings in Hazelton Group strata in the Smithers-Houston area that possess characteristics of volcanogenic massive sulphide deposits. Many have a long, but rather superficial exploration history. Most work was done during the 1960s and 1970s with some notable new activity in the 1990s. Little drilling was done in the early exploration period for a variety of reasons, but probably a strong perception was that the depositional environment and mineralization in the Hazelton Group did not conform adequately to the ore deposit model of the day. Since then, the knowledge of the Hazelton Group stratigraphy and depositional setting has been improved by the work of McIntyre and co-workers at the B.C. Geological Survey and discovery of Eskay Creek, an atypical volcanogenic massive sulphide deposit, has broadened understanding of massive sulphide depositional environments. The purpose of this paper is to summarize the stratigraphic position and mineralization at the Ascot, Del Santo, Lakeview, Harry Davis and SU showings. Their stratigraphic position and tectonic setting is compared to Eskay Creek, the most notable volcanogenic massive sulphide deposit in the Hazelton Group, and found to be different. The comparison is intended to broaden our understanding of potential for VMS deposits in the Hazelton Group. There are several stratigraphic levels within Hazelton Group favourable for polymetallic massive sulphide deposits.

HAZELTON GROUP STRATIGRAPHY IN THE BABINE RANGE

The Geological Survey of Canada mapped the Smithers map-area at a scale of 1:253 440 in the 1970s (Tipper, 1976). More detailed mapping was carried out by MacIntyre *et al.* (1987a, 1987b, 1989) in the Babine Range. A regional compilation by MacIntyre *et al.* (1994) includes data from mineral claim assessment reports. Figure 1 shows the location of the Ascot, Del Santo, Lakeview, Harry Davis and SU prospects in the Babine Range. The Babine Range lies within the Stikine Terrane which consists of the Late Triassic Takla Group (submarine calc-alkaline to alkaline island arc volcanic rocks), the Early to Middle Jurassic Hazelton Group (subaerial to submarine calcalkaline island-arc volcanic and sedimentary rocks) and the Late Jurassic to Early Cretaceous Bowser Lake Group (siliciclastic basinal sedimentary rocks). Post-accretionary strata comprise the middle to Late Cretaceous Skeena and Sustut Groups (continental clastic sedimentary rocks) and the Late Cretaceous to Early Tertiary Kasalka, Ootsa Lake and Endako groups (continental volcanic rocks). Hazelton Group rocks predominate in the Babine Range.

The Hazelton Group in the Babine Range is divided into the Telkwa, Nilkitkwa and Smithers formations. The lowermost Telkwa Formation is most extensive and consists of green and maroon, submarine and subaerial pyroclastic and lava flow volcanic rocks ranging in composition from andesite to rhyolite. Its age is Sinemurian to early Pleinsbachian. In the Babine and Telkwa ranges MacIntyre *et al.* (1989) recognize four map units:

- an upper siliceous pyroclastic facies; quartz-feldspar-phyric ash flows, breccia, air-fall tuff and minor basalt and rhyolite flows;
- basalt flow and red tuff facies; amygdaloidal, augite-phyric basalt, basalt tuff, red tuff and epiclastic rocks;
- andesite pyroclastic facies; thick-bedded, feldspar-phyric andesite breccia, tuff and flows ;
- a basal conglomerate.

Tipper and Richards (1976) assign rocks in the Babine Range to the Babine shelf facies, transitional from nonmarine volcanic rocks that underlie the Telkwa Range to the west, to thick deposits of marine rocks in the vicinity of Babine Lake, to the northeast.

In the Babine Range, the Telkwa Formation is conformably overlain by marine sedimentary and submarine volcanic rocks of Pliensbachian to early Toarcian age, assigned to the Nilkitkwa Formation (Tipper and Richards, 1976). In the Telkwa Range, the Telkwa Formation is disconformably overlain by subaerial, brick-red crystal and lapilli tuff and amygdaloidal basalt. These mid-Pliensbachian to mid-Toarcian rocks were formerly assigned to the Red Tuff member of the Nilkitkwa Formation but were reassigned to the new Eagle Peak formation by MacIntyre *et al.* (1994). In the Dome Mountain area, the Nilkitkwa

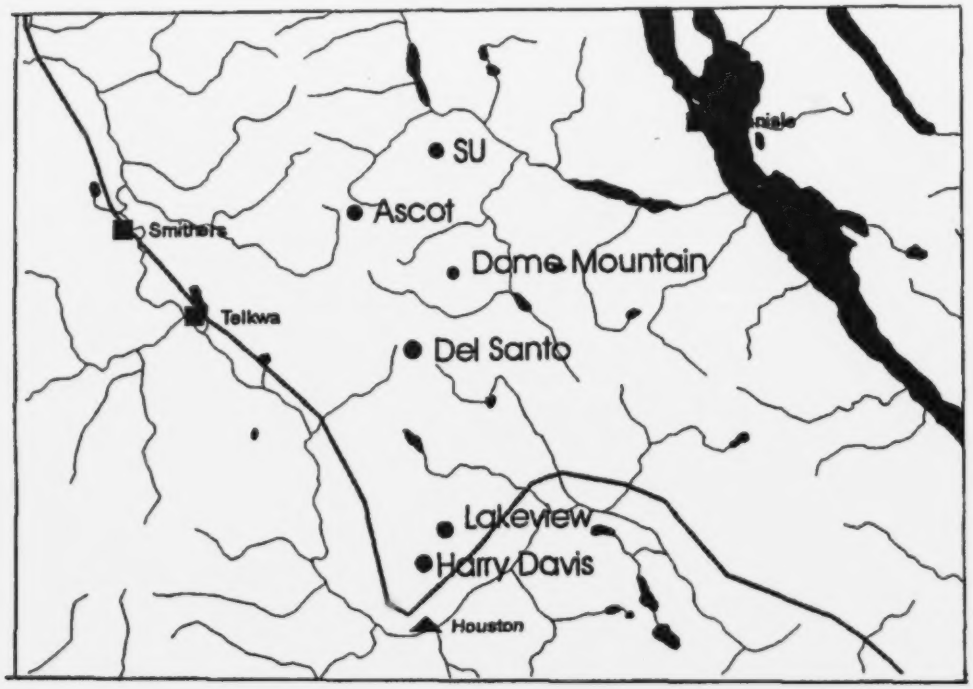

Figure 1. Location map of Ascot, Del Santo, SU, Lakeview and Harry Davis prospects.

Formation is divided into four units of a progressively deeper basin (MacIntyre, 1987a; from youngest to oldest):

- thin-bedded argillite, chert and limestone;
- tuffaceous conglomerate, cherty tuff and siltstone;
- rhyolitic volcanic rocks;
- amygdaloidal andesite or basalt flow interbedded with red epiclastics.

In the Bait Range, 100 kilometres to the north, sedimentary strata in the Nilkitkwa Formation reach a maximum thickness of 1000 metres, but in the Babine Range it is much thinner, about 150 metres. Regionally, acidic volcanism was dominant and no thick piles of volcanic rocks accumulated, but in the Bait Range up to 1000 metres of pillow basalt thick was erupted (Tipper and Richards, 1976). Diabase sills and dikes, probable feeders to the overlying basalt, form an integral part of the Nilkitkwa section in the Bait Range.

The transgressive Nilkitkwa Formation is overlain disconformably by the regressive, upper Aalenian to upper Bajocian, Smithers Formation. In the Babine Range, these shallow-marine sedimentary rocks are characterized by very fossiliferous sandstone and siltstone.

GEOLOGY AND VOLCANOGENIC SETTING OF MINERAL DEPOSITS

1) ASCOT PROSPECT

The Ascot property, covering a 5-kilometre belt of mineral showings, is situated in the Babine Mountains 30 kilometres east of Smithers (Figure 2). It is at the topographic divide between Canyon Creek, which flows southwest to the Bulkley River, and Stimson Creek which drains northwest to the Fulton River and Babine Lake. Access is by means of an unmaintained dirt road which leaves the Smithers-Babine Lake road at Kilometre 21and ascends Canyon Creek. The area consists of rounded hills with intervening subalpine meadows and small lakes. Elevation ranges from 1300 to 1600 metres. The inactive Dome Mountain gold mine is 8 kilometres southwest of the centre of the Ascot claims.

Galena-sphalerite-barite showings were discovered near the head of Canyon Creek in 1951 but not explored at that time. The earliest significant work, in 1967-1969, was by Texas Gulf Sulphur Company which acquired the property as a result of a reconnaissance silt survey. Geological mapping, soil geochemistry and EM surveys were done, followed by one drill hole. (Two other holes, referred to in Minfile, were drilled west of the Ascot showings.) During the 1970s and 1980s the main showings were re-staked and/or optioned numerous times

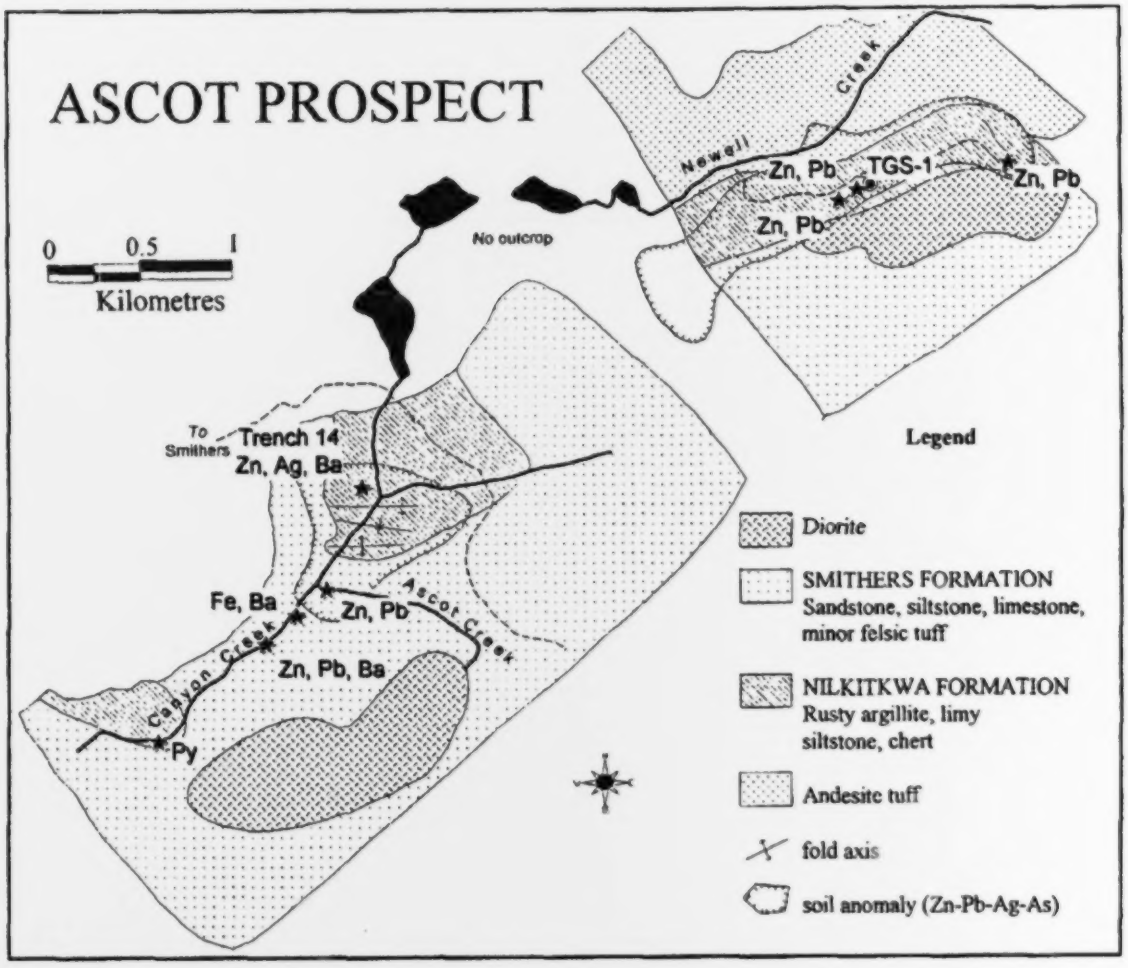

Figure 2. Geological sketch map of the Ascot prospect, after Helgason (1988).

and minor programs conducted by prospectors and companies, including Geostar Mining Corporation (1984), Noranda Exploration Company (1985) and Canadian United Minerals Ltd. (1986). A comprehensive program was conducted in 1987 by Geostar Mining Corporation, and included backhoe trenching which revealed several new mineral occurrences. The most recent work was performed by Alliance Mining Inc. in 1996.

Peatfield and Loudon (1968) described geological mapping of the Ascot area and were first to recognize the presence of rhyolite, the stratabound control and possible volcanogenic origin of mineralization. Significant advances have been made by Price (1978), Helgason (1988) and Lehtinen (1996). Mineralization is contained within a mixed sedimentary and felsic volcanic unit, comprising black carbonaceous argillite, argillaceous wacke, limy siltstone, limestone, rhyolite to dacite breccia and andesite, that trends northeast across the Ascot property. A thick section of massive rhyolite outcrops in lower Byron Creek to the east. Detailed mapping in the vicinity of the showings is difficult due to gradational contacts, facies changes and lack of a distinct marker bed (Lehtinen, 1996). The sediment-volcanic unit is correlated with the uppermost unit of the Nilkitkwa Formation by Helgason (1988). In Newell Creek, a fork of upper Stimson Creek, it is about 250 metres thick and is overlain to the southeast by volcanic sandstone, siltstone and greywacke of the Smithers Formation. To the northwest, it is underlain by andesite that is described as massive and fragmental (Helgason, 1988) or amygdaloidal by MacIntyre (1987a). In upper Canyon Creek, bedding orientation is variable and dip reversals are common. Tight folding is interpreted by Peatfield and Loudon (1968) and Lehtinen (1996) and the simple map distribution, due to sparse outcrop, belies a complex

structure. A property-wide, 5473-sample survey shows soil overlying the Nilkitkwa sediment-volcanic unit is enriched in zinc (300 to 5900 ppm), lead (35 to 500 ppm), and arsenic (50 to 500 ppm).

Five sphalerite-galena-barite occurrences were described by Peatfield and Loudon in Canyon Creek and several more have been found by Price (1978, 1984), Helgason (1988) and Lehtinen (1996). Mineralization consists of pale sphalerite, galena, and locally chalcopyrite, as fine disseminations and bedding-parallel laminations within felsic tuff and dolomitic (tuffaceous?) siltstone. There is little pyrite and mineralization is difficult to recognize. Barite also occurs as fine disseminations and as coarsely crystalline veins or lenses. Price also reports minor tetrahedrite and arsenopyrite. He drilled three packsack holes totaling 7.0 metres in the Canyon Creek showings, obtaining a best intercept of 1.6% Zn over 3.5 metres. Trench 14, excavated on the basis of anomalous soil, uncovered mineralization grading 6.5% Zn and 50 g/t Ag across an estimated true width of 8 metres (Helgason, 1988). Re-sampling of the trench by H. Awmack (pers. comm. 1996) returned 8% Zn and 10% Ba over 4 metres. A lens of massive pyrite outcrops south of the zinc-lead showings in Canyon Creek, at the contact between rhyolite and graphitic argillite. Mineralization near Newell Creek, tested by the Texas Gulf drill hole, also consists of finely disseminated sphalerite and galena in felsic tuff. Texas Gulf did not report any results, but Price (1978) obtained 0.67% Zn from a 14.6 metre composite sample.

2) DEL SANTO SHOWING

The Del Santo property lies 35 kilometres southeast of Smithers, near the headwaters of Deep Creek in the Babine Range. The property is reached by the Deception Lake road, an unmaintained dirt track which leaves the gravel-surfaced Kerr road 5 kilometres from Highway 16. The area of the Del Santo copper-zinc showing is a hilly, forested upland at an elevation of 1200 to 1450 metres. Outcrops are rare below 1380 metres. Open cuts were developed on the showing in 1928. From 1967 to 1970 the property was explored by Texas Gulf Sulphur Company, Falconbridge Nickel Mines Ltd. and Bovan Mines Ltd., by bulldozer trenching, geological, geochemical and geophysical surveys, and 82 metres of drilling in four holes. Petra Gem Explorations of Canada Ltd. performed a pulse EM survey in 1979. In 1997, Telkwa Gold Corp. completed trenching, geological mapping, a Max-Min EM survey and drilled four holes.

The Del Santo prospect (Figure 3) has been mapped by MacIntyre (1986) and in detail by Tompson and Cuttle (1998). The property is largely underlain by amygdaloidal mafic flows and tuffs, with minor interbedded maroon horizons, assigned to the lower unit of the Nilkitkwa Formation. Dacite to rhyolite, and a thin but diverse sedimentary unit are intercalated near the top of the mafic sequence. The sedimentary unit is correlated with the uppermost member of the Nilkitkwa Formation (MacIntyre, 1987a) and the underlying tuffaceous conglomerate unit is not present. The sedimentary unit comprises bedded magnetite-chalcopyrite-pyrrhotite, manganiferous chert, argillaceous tuff, limy shale and finely laminated limestone. The Nilkitkwa section strikes north northwest and generally dips steeply east. It is overlain 300 metres east of the showing by greywacke and siltstone of the Smithers Formation. A tight synclinal minor fold, exposed in a trench at the main showing, and bedding reversal to steep west dip east of the showing, provide supporting evidence of a large-scale syncline mapped by MacIntyre.

Mineralization at Del Santo is well displayed in trenches, cut perpendicular to strike, excavated by Telkwa Gold Corp. in 1998 and described by Tompson and Cuttle (1999). Laminated magnetite and vaguely banded to massive chalcopyrite-magnetite-pyrrhotite-pyrite are interlayered with black mafic tuff, limestone and chert. Sphalerite is a minor component. Epidote and chlorite are prominent alteration minerals. The chert has a pink hue, pyrolusite stain is prominent on outcrops and geochemical values for manganese are commonly >10 000 ppm in the trench area. The mineralized sequence is up to 15 metres thick and trenches trace the horizon a distance of 100 metres. Trench 1 assayed 2.11% Cu and 231 g/t Ag across 5.2 metres. Four core holes, drilled under the trenches, confirm the mineralized horizon lies between amygdaloidal mafic volcanic rocks and tuffaceous to pyroclastic felsic volcanic rocks. The felsic sequence includes quartz-eye rhyolite, a lithology not seen on surface. Drill intersections of the mineralized horizon are thinner than seen in the trenches, contain less chalcopyrite, and a higher proportion of pyrite. Umber-coloured beds suggest continued high manganese content. The chert-sulphide horizon is cut off at depth, in hole 98-3, by a massive mafic body that grades from a fine-grained margin to a medium-grained, diabase-textured interior with xenoliths of chert. It is interpreted to be a subvolcanic mafic intrusion. Development of epidote and pyrrhotite in limy horizons appears to be a thermal effect around this mafic body.

Faults have displaced the mineralized beds. EM and magnetic surveys detected anomalies associated with felsic volcanic rocks north of the showing. Perhaps the anomaly east of the showing is related to a second, stacked exhalative massive sulphide horizon at the top of the felsic volcanic unit. These are prime drill targets.

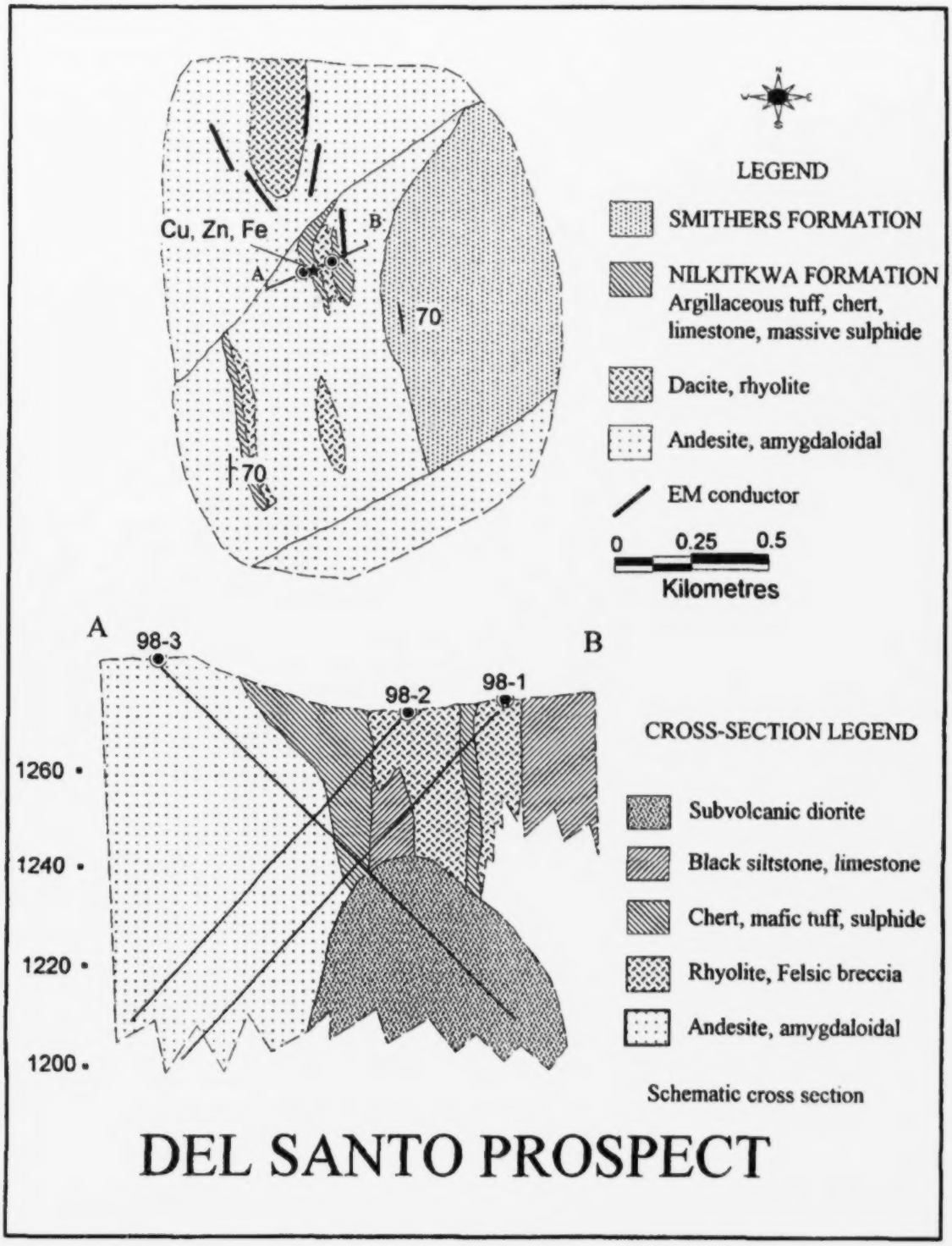

Figure 3. Geological sketch map of the Del Santo prospect, after Tompson and Cuttle (1998).

SU SHOWING

The SU showing is located 40 kilometres east of Smithers, in a clear-cut at Kilometre 80.5 on the Chapman Lake forest service road, about 5 kilometres south of Chapman Lake. Local relief is low. The property lies in a broad valley east of the Babine Range at an elevation of about 900 metres. Logging has enhanced scant rock exposure in a clear-cut adjacent to Bristow Creek which flows northeast to the Fulton River. The SU claims are underlain by Hazelton Group volcanic and sedimentary rocks. An interesting showing of layered clastic pyrite occurs within a volcaniclastic unit and is associated with a strong zinc-lead-silver soil anomaly (Figure 4). The property has been explored by A.T. L'Orsa and Noranda Exploration Company, Limited whose work forms the basis of the following description.

Outcrops of fragmental volcanic rock on the SU property were assigned to the Nilkitkwa Formation by Myers *et al.* (1988). The fragmental rocks comprise 70% andesite and 30% felsic (dacite to rhyolite) clasts, mainly less than 1 centimetre in size. Rhyolite fragments are generally larger and more angular than andesite fragments, suggesting the former have a nearby source. Myers *et al.* (1988) observed layering and gradedbedding, rounding of clasts and a calcite cement, and conclude that the volcanic debris was reworked in a sedimentary environment. Layering strikes northeast and dips about 30° southeast. Grading at three locations shows the beds face east. Individual beds grade upward from conglomerate or sandstone to fine-grained sandstone and siltstone. Evidence of turbidite sedimentation, convolute bedding, rip-up clasts and pelecypod fossil fragments, are recorded by L'Orsa (1992). Northwest of the volcaniclastic rocks a maroon, vesicular andesite unit is delineated by its high magnetic signature and correlated tentatively with the Telkwa Formation. The contact with the overlying volcaniclastic unit is not exposed but Roney *et al.* (1989) suggest it is gradational. Massive gray to black siltstone outcrops at one locality in Bristow Creek and, if the strata form a continuous succession, overlies the volcaniclastic unit.

A showing of clastic, syngenetic pyrite occurs near the base of the volcaniclastic unit. Pyrite constitutes up to 50% of the rock, ranging from minute grains up to angular, 1 to 4-millimetre fragments mixed with siliceous and calcareous clasts of similar size. Roney *et al.* (1989) describe the horizon as a fragment-poor (*i.e.* comparatively quiescent) zone. A 2.1-metre chip sample contained 1 ppb Au, 40.6 ppm Ag, 124 ppm Cu, 240 ppm Pb and 4250 ppm Zn (Myers *et al.*, 1988). L'Orsa (pers.

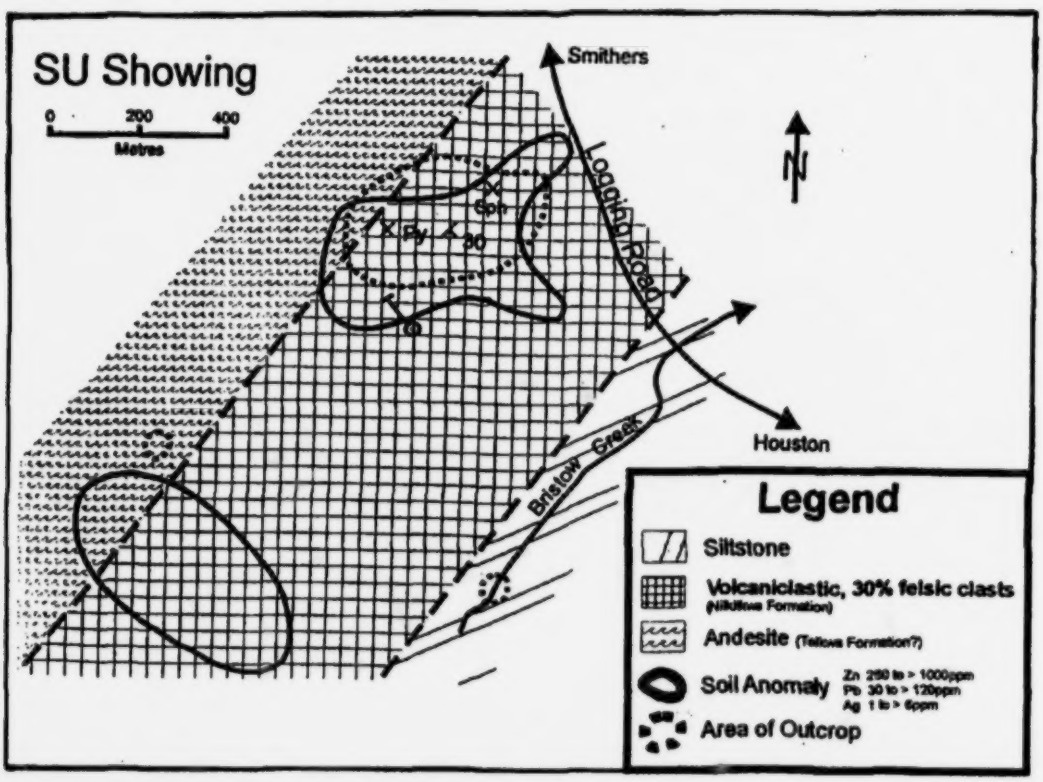

Figure 4. Geological sketch map of the SU showing, after Roney et al. (1989).

comm. 1999) has observed colloform sphalerite at an unreported showing near what appears to be the southwestern end of the system. Sphalerite and galena occur in a calcite veined and cemented, andesite fragmental rock 350 metres northeast of the pyrite showing. More significant bedrock mineralization is suggested by a float rock grading 77 000 ppm Zn and another with 130.9 ppm Ag and 2540 ppb Au. A zinc-lead-silver soil anomaly, 650 metres long, covers the showings. Zinc values range from 250 to 3383 ppm, lead from 30 to 2452 ppm and silver from 1 to 59.4 ppm. A second zinc-lead-silver soil anomaly, slightly smaller in area, is located roughly along strike, 600 metres to the southwest and corresponds to a low hill. These anomalies were evaluated by Myers *et al.* (1988) and Roney *et al.* (1989) based on local evidence of latest ice flow from northwest to the southeast (L'Orsa, pers. comm., 1999). This premise should be evaluated, based on ice flow in the opposite direction determined by Levson *et al.* (1999).

An IP survey by Noranda Exploration Company, Limited delineated two strong chargeability anomalies 600 metre long (Roney *et al.*, 1989). One is located just east of the pyrite showing and is on strike with the sphalerite-galena showing; the second is 100 metres further east. Both underlie the large soil anomaly. A third chargeability anomaly corresponds to the smaller soil anomaly. Both soil and IP anomalies were trenched by Noranda but only 17 of 58 trenches reached bedrock. No economic mineralization was uncovered. In 1992, A.T. L'Orsa drilled one core hole 250 metres south of the pyrite showing, to test the strongest IP response at a point southwest of the showing (L'Orsa, 1992 and pers. comm., 1999). The hole penetrated siltstone then volcanic-derived turbidite and ended in volcaniclastic rocks at a depth of 88 metres. A few massive pyrite clasts were intersected and, near the bottom of the hole, a felsic volcaniclastic section with 10% pyrite locally and minor sphalerite and galena.

4) LAKEVIEW SHOWING

The Lakeview prospect is located 10 kilometres north of Houston, near the southern end of the Babine Range, at an elevation of 1150 metres. It is reached from Houston via the Knockholt and the Summit Lake roads, the latter an unmaintained dirt track. A copper-zinc showing is exposed on the flank of a low hill west of Wilson Lake and was originally staked in 1910. Early exploration of the prospect is reported by Low and Sevensma (1970). Tonopah Mining Company carried out surface stripping and sank three shallow shafts in 1917-1918. In 1955, three holes were drilled by the Harvest Queen Mining Co. and bulldozer trenching was carried out by various companies including Copper Ridge Silver Zinc Mines Ltd. EM surveys were conducted by Buval Mines Ltd. and Butler Mountain Minerals Corp., in 1969 and 1983, respectively. The last significant exploration program was by Golden Vein Explorations Ltd. in 1988 and included geological mapping, soil geochemistry and another EM and magnetic survey.

Outcrop at Lakeview is extremely sparse, and confined to the immediate vicinity of the showings (Figure 5). The hostrocks to mineralization were assigned to the Telkwa Formation by Tipper (1976) and comprise rhyolite and related pyroclastic and epiclastic rocks. These are correlated with the upper unit of the Telkwa Formation, based on more extensive exposure at the nearby Harry Davis prospect (see below). Well-bedded tuff near the Lakeview showing strikes north-northeast and dips very steeply northwest. South of the showing, the trend of EM conductors curves to the north and northwest, suggesting a change in strike. The nearest mapped outcrops of Nilkitkwa Formation are on Grouse Mountain, 6 kilometres to the northwest (MacIntyre *et al.*, 1994). Immediately southeast of the showings, a fault is inferred to have down-dropped Hazelton Group strata beneath a cover of overlying Tertiary volcanic rocks. Andesite dikes, 1 to 2 metres wide, crosscut the showing at a high angle.

The Lakeview showing comprises massive, crudely banded specularite, chalcopyrite, pyrite and sphalerite, that averages 1.8 metres in width, and is intimately associated with a narrow limestone bed intercalated with the acid pyroclastic rocks. The limestone is massive and no fossils are reported. Hematitic chert is also present. The mineralized horizon has been traced a distance of 400 metres by surface stripping. It is associated with epidote, hematite and chlorite alteration, leading early workers to assign mineralization to a skarn or vein model, but no intrusive rock or distinct skarn is exposed. The presence of limestone and chert are evidence of submarine deposition. Mineralization is stratabound and appears to the writer to be volcanogenic. Four samples collected by Christopher (1988) average 1.5% Cu, 3.1% Zn, 45 g/t Ag and 0.5 g/t Au. Harvest Queen's first core hole, near the shaft at the south end of the zone, intersected 7.7% Cu, 0.6% Zn, 141 g/t Ag and 0.85 g/t Au over 1.4 metres (Low and Sevensma, 1970). The other two holes did not reach the zone. Soil geochemical response may be masked by glacial till because copper and zinc anomalies do not extend beyond the 400-metre length of the showing. One exception is an untested soil anomaly 600 to 800 metres southwest of the showing.

5) HARRY DAVIS PROSPECT

The Harry Davis property, also known as H.D., comprises a series of copper, zinc and cadmium showings on Mount Harry Davis, 5 kilometres north of Houston (Figure 6). Mount Harry Davis reaches an elevation of 1250 metres and marks the southern end of the Babine Range. The showings span a 4-kilometre strike length from the southern base to the top of the mountain. They are accessed by a dirt road which services four

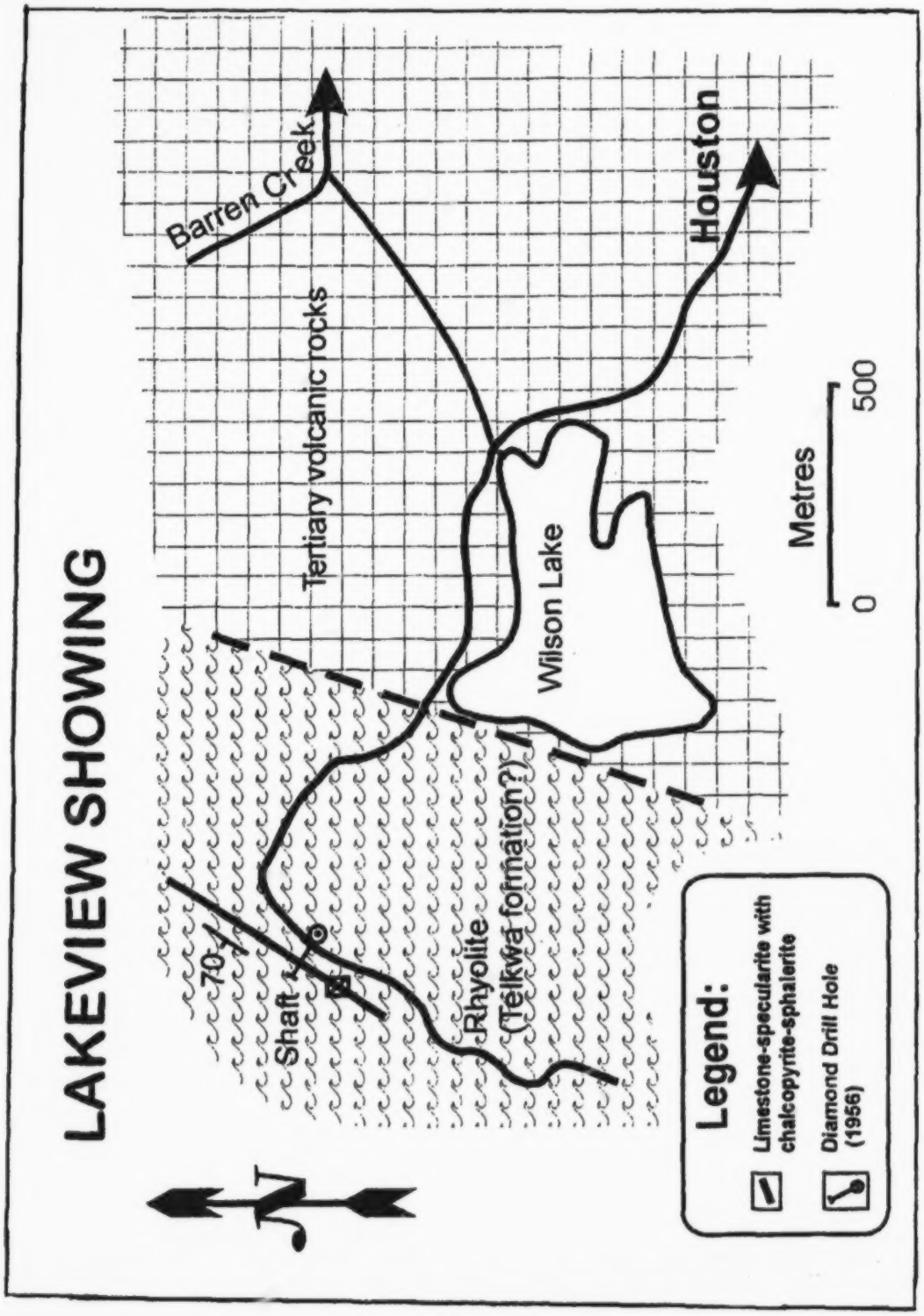

Figure 5. Geological sketch map of the Lakeview showing, after Christopher (1988).

communication towers on the mountain. Outcrop is fairly abundant on the dome-topped mountain but sparse elsewhere. Prospecting of showings on Mount Harry Davis dates from the 1920s. More recent exploration was conducted by Placer Development Ltd. (1981-1982), Eldor Resources Ltd. (1985), Equity Silver Mines Ltd. (1988) and Teck Corp. (1993). In 1998, property owners Wesley Moll and Dan Merkley drilled one core hole.

The crest of Mount Harry Davis is underlain by massive, flow-banded and pyroclastic rhyolite of the Telkwa Formation. Quartz eyes and feldspar phenocrysts are common. The rocks strike north and generally dip steeply to the east, but their facing direction is uncertain. A well-bedded red tuff, with distinctive accretionary lapilli clasts, is intercalated with the rhyolite pyroclastic rocks west of the mineral showings. Accretionary lapilli usually form during subaerial eruption but might accumulate in a submarine setting. Chert, indicative of submarine deposition, is exposed at the Hilltop showing. A body of massive dacite feldspar porphyry, more than 2.5 kilometres long, outcrops east of the showings. Thomson (1994) suggests it is a subvolcanic intrusion. The acid pyroclastic succession may be as much as 1000 metres thick, and such a thickness can only be correlated with the upper unit of the Telkwa Formation. Perhaps the poorly described mafic volcanic rocks that structurally overlie the acid pyroclastic rocks belong to the lower Nilkitkwa Formation, although they were not corrrelated by Tipper and Richards (1976).

At the Hilltop showing, brown sphalerite occurs in massive to laminated chert that strikes northeast and dips gently west, a significant bedding reversal from elsewhere on the property. Sphalerite conforms to the laminae. The chert is underlain by rhyolite and overlain by a thin andesite unit. Fluorite occurs as inclusions with secondary quartz and sphalerite (Cruickshank, 1985; Thomson, 1994). Discordant quartz and calcite veins, with sphalerite and galena, are also present. Strong zinc and cadmium soil anomalies surround the Hilltop showing. Cadmium appears to be present as a yellow fracture-coating of greenockite in the Hilltop trenches. Drilling by Teck (holes 93-2 and 93-4) intersected quartz-carbonate alteration within rhyolite, with an average of 1.0% Zn over 7 metres, but did not intersect chert or stratabound sphalerite. Cruickshank (1985) interpreted a gradation from apparently sygenetic mineralization at the Hilltop showing to epigenetic mineralization at the showings described below.

The Tower, Baseline and Switchback showings consist of disseminated to fracture-controlled pale green sphalerite, with lesser chalcopyrite, galena and fluorite, and associated secondary quartz and calcite (Cruickshank, 1985; Thomson, 1994). The Tower showing includes a silicified tectonic breccia. Fracture-controlled azurite and malachite occurs in andesite at the Zone showing (Harper, 1970; Cruickshank, 1985) but holes drilled under the showing encountered disseminations and fracture fillings of quartz and specularite, and no primary copper minerals (Gagnier and Hanson, 1989). On the North road, chalcopyrite and bornite, extensively altered to malachite, occur as disseminations and on microfractures in amygdaloidal mafic volcanic rock that overlies the pyroclastic rhyolite unit.

DISCUSSION

Two stratigraphic levels of mineralization are represented by the prospects reviewed in this paper: (1) in the uppermost member of the Nilkitkwa Formation and (2) near the top of the Telkwa Formation. Mineralization in the upper Nilkitkwa, the Ascot, Del Santo and SU prospects, offer the best evidence of volcanogenic mineralization. Bedded sulphides occur in a sedimentary unit with clastic and chemical sediments, in close proximity to felsic volcanic rocks. The copper-iron mineral assemblage at Del Santo suggests a vent-proximal setting, in contrast to the iron-poor, lead-zinc-barite assemblage at Ascot, which suggests deposition distal from a hydrothermal vent. Mineralization in the upper Telkwa, the Harry Davis and Lakeview prospects, is associated with thin horizons of chemical sediments intercalated with rhyolite. Their volcanogenic origin is less certain. At Harry Davis, the volcanic setting may have been transitional from subaerial to submarine, as there is evidence of both environments. The Lakeview showing is the least well known, due to lack of data. It may be significant that mineralization from Lakeview is comparable to Del Santo; crudely banded iron oxide, magnetite or specularite, with chalcopyrite and sphalerite in association with limestone and epidote alteration. All five of these prospects merit continued exploration for volcanogenic massive sulphide deposits.

MacIntyre *et al.* (1989) recognize three volcanic-sedimentary cycles in the Hazelton Group, each separated by a disconformity. The first cycle, represented by the two lower members of the Telkwa Formation, consists of pyroclastic andesite that grades upwards into a very thin sedimentary member containing Sinemurian fossils. The second cycle comprises a bimodal volcanic accumulation in the upper Telkwa Formation. It begins with subaerial amygdaloidal basalt, passing upward into siliceous pyroclastics and rhyolite flows. Lakeview and Harry Davis are believed to have formed near the end of this cycle. The final volcanic-sedimentary cycle, also a bimodal suite, begins with amygdaloidal basalt, subaerial in part, followed by felsic pyroclastics which are onlapped by marine sediments in a fining-upward, progressively deeper basin. Ascot, Del Santo and SU formed near the end of this third cycle.

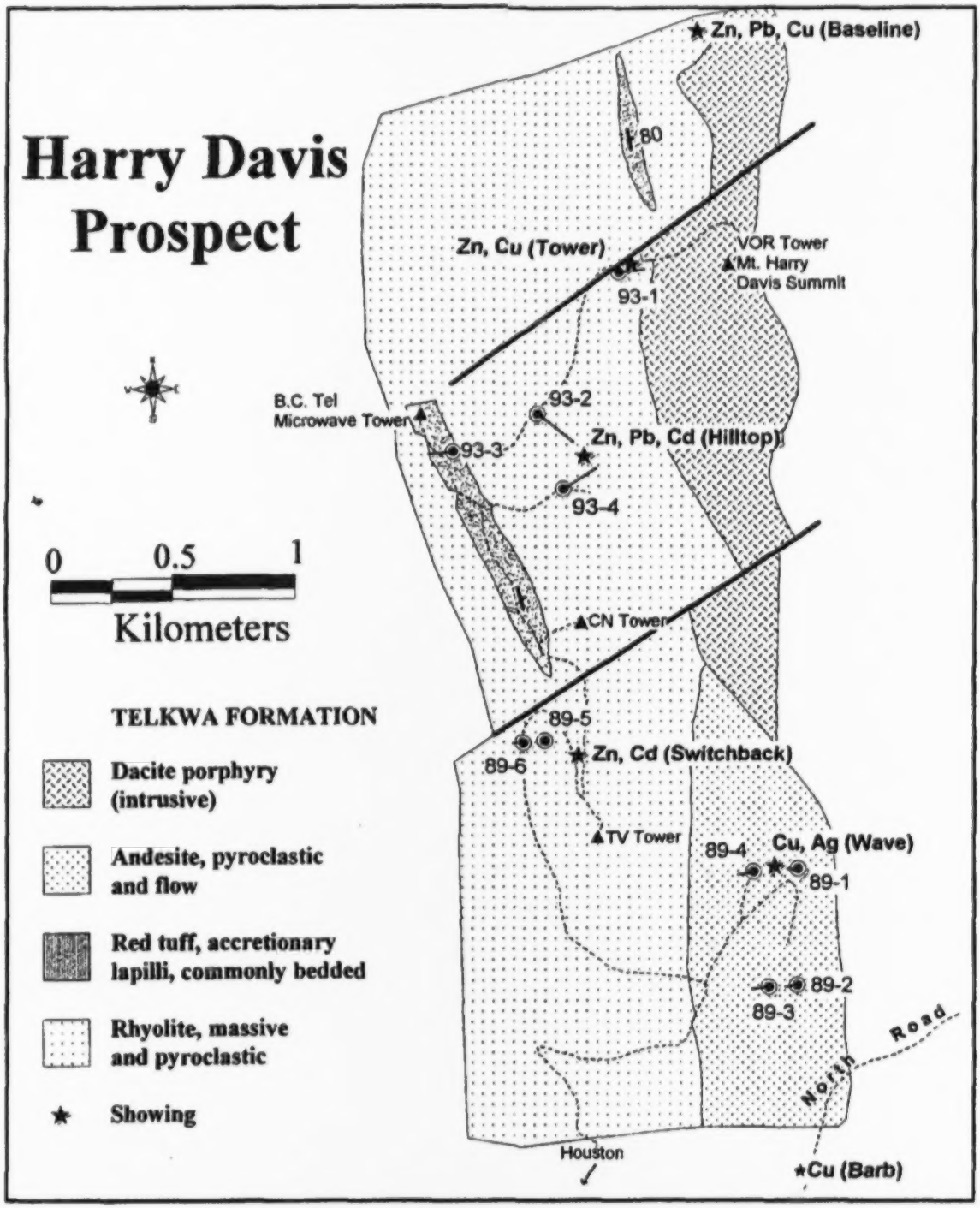

Figure 6. Geological sketch map of the Harry Davis prospect, after Cruickshank (1985) and Thomson (1994).

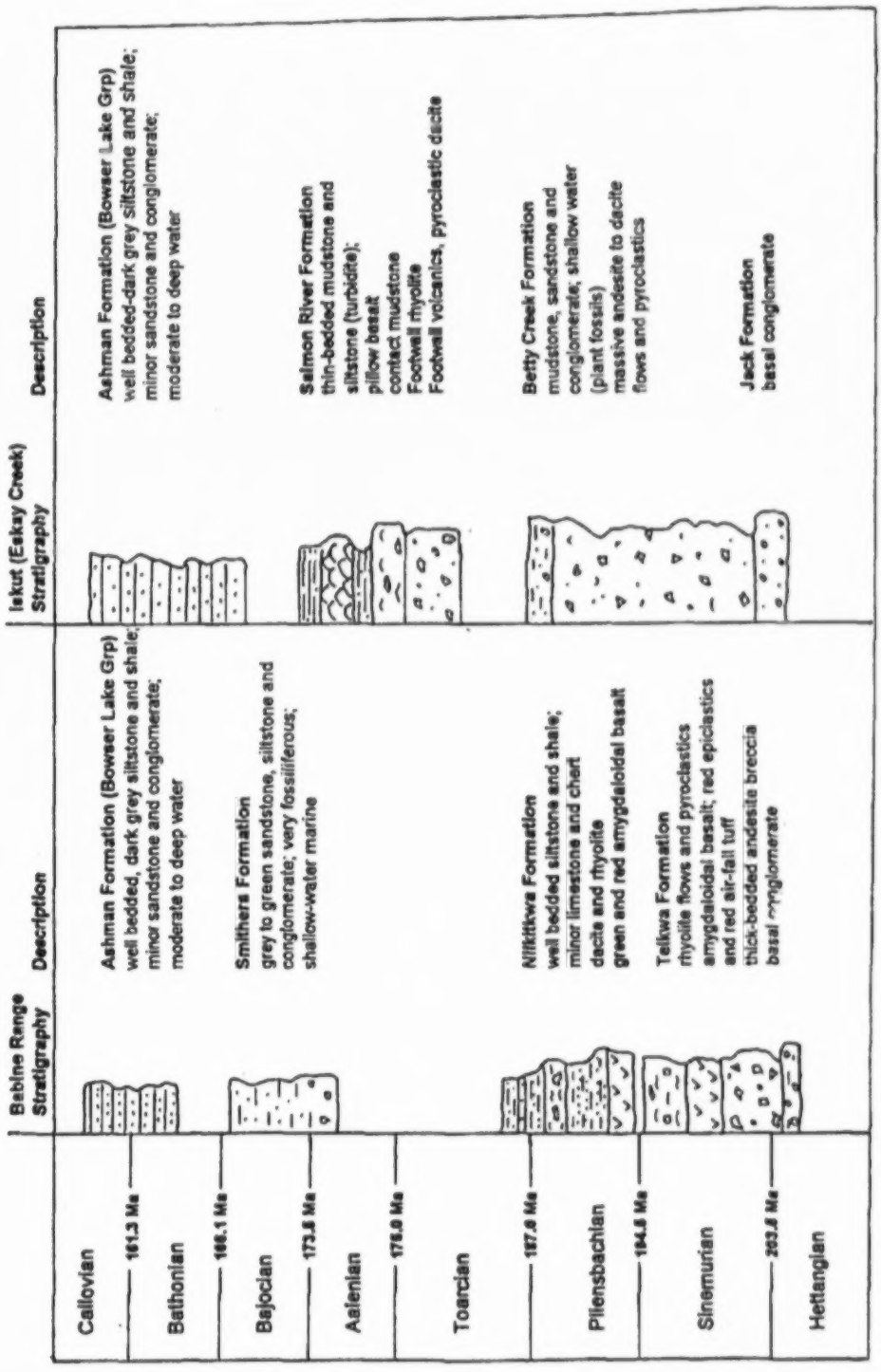

Figure 7. Comparison of Hazelton Group Stratigraphy in the Babine Range and Iskut District

Based on stratigraphic studies by MacIntyre and co-workers, the age of Telkwa Formation exhalative mineralization in the Babine Range is latest Sinemurian. The younger Nilkitkwa mineralizing event is late Pliensbachian to early Toarcian. Eskay Creek, the most significant and best studied volcanogenic massive sulphide deposit in the Hazelton Group, is Aalenian age (MacDonald *et al.*, 1996), significantly younger than massive sulphides in the Babine Range. Hazelton Group stratigraphy in the Iskut district and Babine Range is compared in Figure 7. Rocks of Toarcian to Aalenian age are apparently missing from the stratigraphic record in the Babine Range. During Bajocian time, the shallow-marine environment of the Smithers Formation is unlike the deep turbidite basin of the Salmon River Formation. The tectonic setting at Eskay Creek is not duplicated in the Babine Range. Massive sulphide deposition at Eskay Creek occurred at the inception of back-arc rifting and eruption of thick, but areally restricted, pillow basalt. Such an event is not evident in the Babine Range, but may be represented further north, in the Bait Range, where thick pillow basalt, the Carruthers and Ankwell members of the Nilkitkwa Formation are described by Tipper and Richards (1976).

ACKNOWLEDGEMENTS

I thank Will Tompson, Jim Cuttle, Tony L'Orsa, Lorne Warren, Jim Lehtinen and Wes Moll for their hospitality during property visits and for sharing information and ideas. I am very grateful for the generous assistance of Daryl Hanson, Bruce Madu and Sandee Ennis in the preparation of the figures.

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DOMINION CREEK (093H 133)

By Alan R. Raven[1] and Robert A. Lane

LOCATION:	Lat. 53° 27'N Long. 121° 16'W	(93H/6)
	CARIBOO MINING DIVISION. The Dominion Creek property is located along Dominion Creek, a tributary of Haggen Creek, near Clear Mountain approximately 43 kilometres north-northeast of Wells and about 110 kilometres east-southeast of Prince George.	
CLAIMS:	AK I-IV, AK 7,9-14, DOM4 and DM 15-17 (59 units).	
ACCESS:	East on Highway 16 from Prince George to the Bowron forest service road (FSR); south for 85 kilometres on the Bowron FSR; southeast for 104 kilometres on the Narrow FSR; east for 22 kilometres on the Haggen FSR, and; southeast on the old Rustad road past the last cut block to the original property access trail. The final 13 km is not graveled and a 4-wheel drive vehicle may be required to access the property.	
OWNER/OPERATOR:	Alan Raven	
DEPOSIT TYPE:	Mesothermal vein	
COMMODITIES:	Gold, silver, lead and zinc.	

EXPLORATION HISTORY AND GEOLOGY OF THE DOMINION CREEK MESOTHERMAL VEIN PROSPECT, EAST-CENTRAL B.C.

INTRODUCTION

The Dominion Creek property (MINFILE No. 093H 133) is located along Dominion Creek, a tributary of Haggen Creek, in the northern Cariboo Mountains of central British Columbia (Figure 1). The terrain across the property is moderate to steep. Most of the area is forested with mature stands of spruce and balsam fir, along with a dense underbrush of dwarf willow, huckleberry and devils club. Several high grade precious and base-metal mesothermal veins were discovered by prospecting in 1986. Systematic exploration has outlined a number of new geochemical anomalies, and several of these have not yet been tested. Limited trenching and diamond drilling has mainly targeted the North and South zones. Favourable results led to the development of a small open cut and processing of a small bulk sample from the South zone. This report is a compilation of work done on the property to date. It builds on reports by Savell and Bradish (1987), Savell (1988), K.V. Campbell (1988) and T. Campbell (1988).

EXPLORATION HISTORY

The Dominion Creek watershed was identified as being geochemically anomalous in lead, cobalt, iron, arsenic and antimony by a Regional Geochemical Survey (British Columbia Regional Geochemical Survey 12, Geological Survey of Canada Open File 1107) conducted in 1984. The survey outlined a northwesterly trending multi-element anomaly that extends from the headwaters of Littlefield Creek to the confluence of Dominion and Haggen creeks, a distance of some 14 kilometres. Boronowski resampled the drainage in 1985 using a panned concentrate stream sediment technique. He obtained comparably favourable results and registered gold values up to 1000 ppb (Boronowski, 1986). The same year, high grade gold vein mineralization was discovered near Dominion Creek by Nathen Kencayd while prospecting for placer gold in the Haggen Creek watershed. He collected samples of sulphide-rich quartz vein float and submitted them to the Noranda Exploration Company Limited regional office in Prince George for analysis. Assays were very encouraging (some in excess of 1 oz/ton Au) and led to staking of what were to become the North and South zones (Figure 2). Additional ground was staked later in the year, after Noranda negotiated an option agreement with Kencayd. The company explored the property from 1986-1988, in joint venture with International Rhodes Resources Inc., using flow-through funding. Soil geochemistry surveys identified a number of multi- element (Au-Zn-Pb-Cu) anomalies within the Dominion Creek drainage basin

[1] High Range Exploration Ltd., Box 80, Garden Bay, British Columbia V0N 1S0

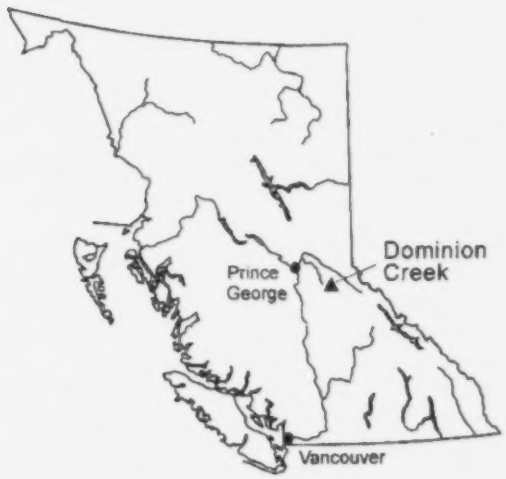

Figure 1. Location of the Dominion Creek property.

including the North and South zones. Trenching across the two zones located several auriferous quartz-sulphide veins including the 3B vein (South zone) which graded 31.8 g/t Au over 4.4 metres. Follow-up diamond drilling, totaling 3484 metres of diamond drilling in 53 holes, confirmed grade and width of several of the veins.

In 1989, despite promising exploration results, International Rhodes pulled its funding for the project. In addition, Noranda concluded that the tonnage potential of the property was limited and dropped its option. Later in the year, Alan Raven purchased the property from Kencayd and resumed exploration. His work included a detailed re-examination of all data, additional structural interpretation and stripping of the South zone showing. Between 1990 and 1992, with Aquila Resources Limited as a joint-venture partner, an 1180 tonne bulk sample from the South zone was mined and milled (Photo 1). The bulk sample was extracted primarily from a small open cut developed on the 3B vein (Photo 2). A limited tonnage also was taken from surface exposures of the 2B vein. Ore was stockpiled onsite and then trucked to a portable flotation mill that was set up at the 103-kilometre marker on the Narrow forest service road. Mill head grades averaged 14.1 g/t Au and gold recovery averaged about 93% (G. Hawthorn, personal communication, 1992). Approximately 80 tonnes of concentrate were recovered and shipped to the Cominco smelter in Trail for processing.

The property was inactive until 1997 when the joint venture partnership of Applied Mine Technologies Inc. and Gold City Mining Corporation briefly optioned the property and staked additional claims. However, they were unable to raise financing and were forced to drop their option later in the year. In 1998 Raven undertook a detailed float prospecting and soil geochemistry program. His results strongly suggest that there is potential for other gold veins to be discovered.

REGIONAL GEOLOGY

The northern Cariboo Mountains occur within the Cariboo Terrane of the Omineca belt. They are underlain by Upper Hadrynian to Cambrian continental shelf clastics and carbonates of the Kaza and Cariboo groups. The Cariboo Group lies conformably on Kaza Group sedimentary rocks (quartzite, phyllite and limestone) and is divided into seven formations that, from youngest to oldest, are: Isaac, Cunningham, Yankee Belle, Yanks Peak, Midas, Mural and Dome Creek (Campbell, 1967; Campbell *et al.*, 1973; Struik, 1988). The rocks are deformed into a series of northwesterly plunging major fold structures that are cut by later brittle faults. A major northwest-trending structure, the Isaac Lake Fault, separates the Lanezi arch or anticlinorium to the west from the Isaac Lake synclinorium to the east (Sutherland Brown, 1947). All rocks have been subjected to chlorite-grade regional metamorphism.

PROPERTY GEOLOGY

The property is underlain by sedimentary rocks of the Isaac and Cunningham formations (Figure 2). The Isaac Formation consists predominantly of dark grey to black, finely laminated, phyllitic to slatey argillite. It is variably graphitic, calcareous and pyritic. Pyrite forms medium to coarse-grained cubes with pressure shadows of quartz or calcite. Lesser amounts of grey siltstone and quartzite are interbedded with the argillite. Grey to black micritic limestone also forms a major component of the Isaac Formation, especially near the upper gradational contact with the overlying Cunningham Formation. This limestone is interbedded with argillite and forms beds up to about 30 metres thick. The Cunningham Formation consists of medium grey, massive to faintly laminated, micritic to finely crystalline limestone with minor interbeds of graphitic argillite. The strata generally strike northwest to west-northwest and dip moderately to steeply southwest. The axis of a southeast plunging anticline follows Dominion Creek near the east edge of the property (Savell, 1988). Rocks in the vicinity of the legal corner post for the AK claims have an easterly strike.

The area has a complex deformational history. Bedrock exposures and diamond drill core display highly contorted and intricately folded laminations. Local intense shearing within the argillite has destroyed delicate primary laminations and caused fracturing and brecciation of limestone. A major northwest trending fault cuts through the centre of the property. It is expressed by topographic lineaments and abrupt lithological contacts. This structure has a strike of about 145° and is thought to be the northern extension of the

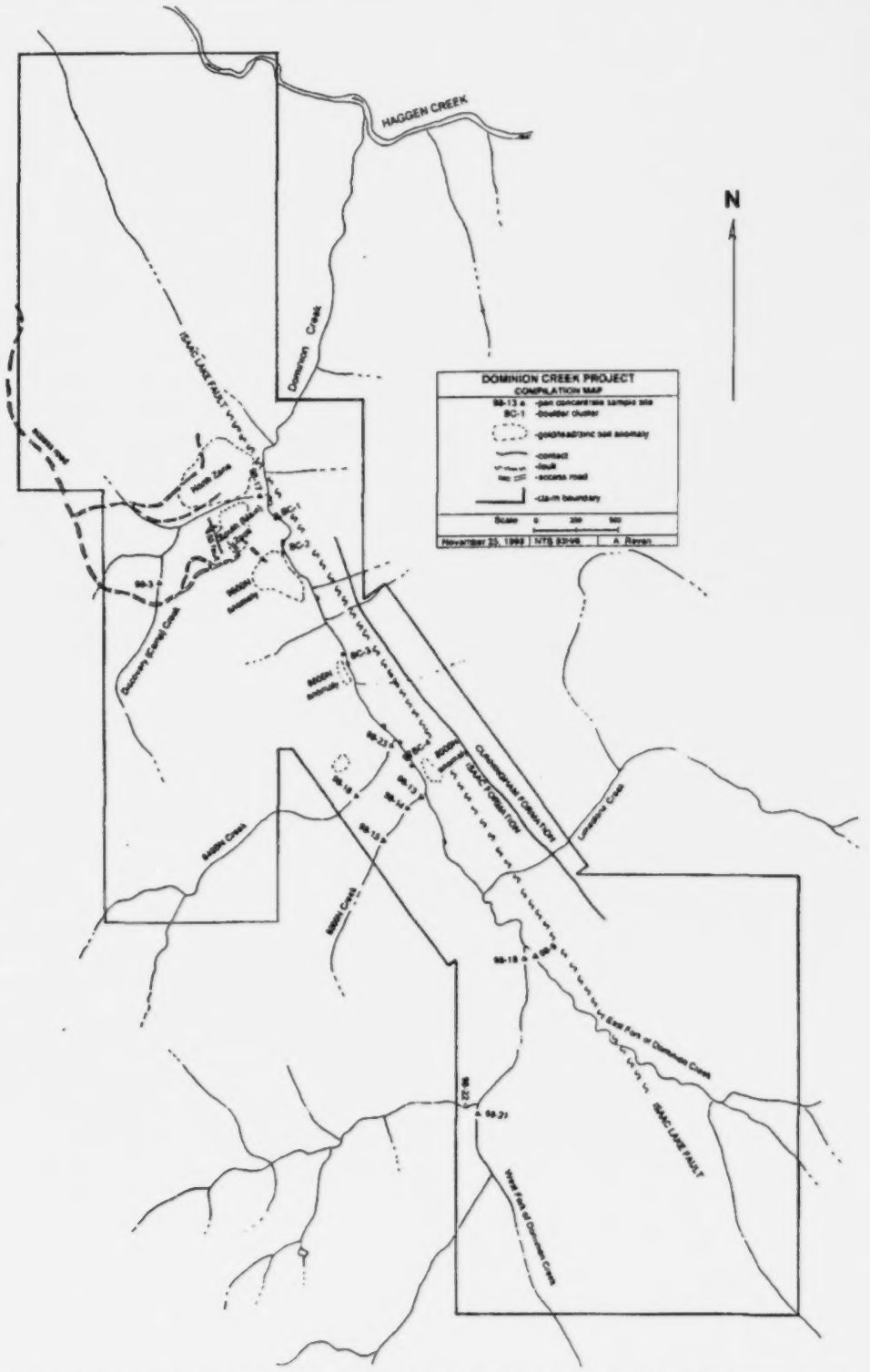

Figure 2. Compilation map of the Dominion Creek property showing the location of the North and South zones, soil geochemical anomalies and float boulder and pan concentrate sample sites.

Photo 1. Opening up of the 3B vein, South zone, using rock drills (1990 field season).

Isaac Lake Fault (Savell and Bradish, 1987). Several subordinate faults with trends of about 155° are interpreted to be splays of the Isaac Lake Fault. There are two prominent joint sets. The first is sub-parallel to foliation, which is usually parallel to bedding; the second is generally perpendicular to foliation and dips steeply to the east. Both are typically filled with quartz and/or calcite, but neither is mineralized.

MINERALIZATION

Auriferous mesothermal quartz-sulphide veins are developed in limestone and argillite of the upper Isaac Formation west of the Isaac Lake Fault. Two sets of veins have been identified; 'B' veins are localized along planes parallel to bedding and/or cleavage, and 'A' veins occur in structures sub-parallel to the Isaac Lake Fault (Figure 3). 'B' veins are more numerous. Some lithologies within the Isaac Formation appear to have been more receptive to vein development than others. The prominent 2B and 3B veins occur in a brown-weathering, pyritic, argillaceous and dolomitic limestone. 'B' veins consistently trend west-northwest (100° to 110°) and dip 50° to 70° southwest, but locally can be structurally complex. Along strike 'B' veins pinch and swell and anastomose over short distances into quartz stringer, breccia or intensely silicified zones (Savell, 1988). They are also crosscut by faults that result in minor displacements. In the South zone, 'B' veins are interpreted to have been drag-folded by dextral movement on the 155 fault (Figure 3). Fault-controlled or 'A' veins are developed along northwest-trending subvertical structures (generally oriented between 150° to 160°). The 1A (or 155 vein) is the most significant of these discovered to date.

Vein mineralogy consists of quartz, with minor ankerite and/or calcite, graphite, galena, sphalerite, pyrite, chalcopyrite, and trace amounts of native gold. The quartz is generally milky white and fine grained. Ankerite is pale brown-grey and occurs as medium-grained clusters. Graphite may be present as thin slivers or coarse patches. Calcite is minor, but where present occurs as narrow veinlets. Inclusions of angular, silicified wall rock fragments are fairly common, especially in the larger veins.

Sulphide content is erratic along strike, but is generally higher in veins near the 155 fault. It ranges from zero to more than 10% locally. Sulphides are generally very fine to fine-grained and typically occur as irregular patches dispersed throughout the veins. Less commonly they form narrow bands several metres long. Galena and sphalerite occur in approximately equal amounts and are typically more abundant than pyrite. Chalcopyrite generally occurs in trace amounts. Native gold has not been identified in hand sample, but in polished thin section occurs as grains from 0.01 to 0.03 mm across. Most is associated with galena, and some occurs within fractures in pyrite and in quartz (Savell and Bradish, 1987).

There is a strong positive correlation between sulphide content and gold grade in most of the veins. However, multi-gram gold assays have been encountered in sulphide-poor veins (*e.g.* core sample #17918 from hole DC-87-21 assayed 78.79 g/t Au, <0.01% Pb and <0.01% Zn over 0.65 m, and the weighted average of consecutive core samples 82539 and 82540 from hole DC-87-2 assayed 21.23 g/t Au, 0.01% Pb and 0.05% Zn over 2.6 metres). A review of assay data from holes DC-87-1 to DC-87-16 drilled on the South zone veins, showed that gold:silver ratios range from 0.03 to 18, but are typically between 0.2 and 0.5. High silver assays, locally exceeding 400 g/t, are associated with galena-rich veins.

A brief description of the veins is summarized from Savell and Bradish (1987). The South zone (Figure 3) comprises four main veins, the 1A, 1B, 2B and 3B. The

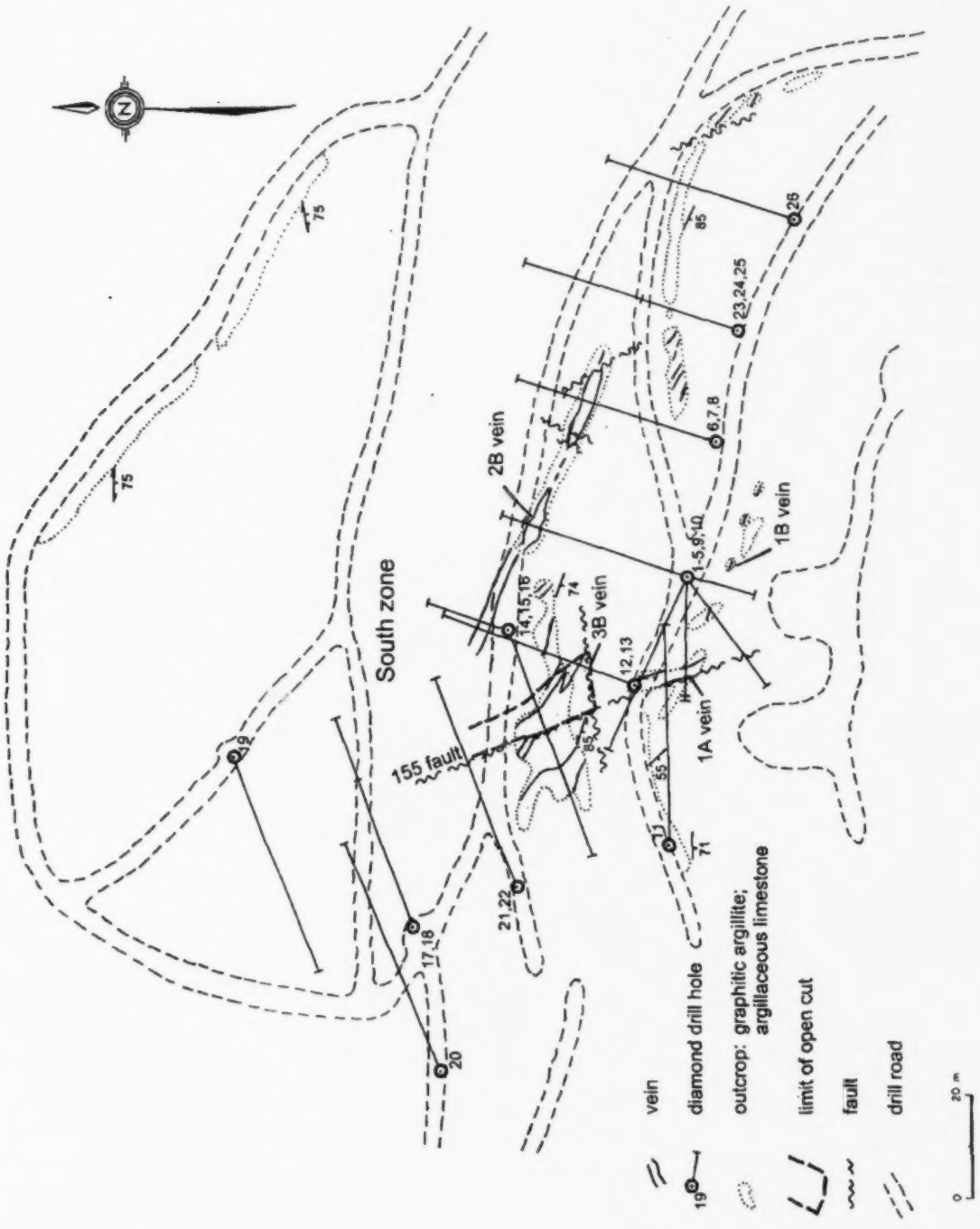

Figure 3. Map of the South zone showing the location of veins, diamond drill holes and distribution of outcrop prior to development of the open cut (modified after Savell and Bradish, 1987).

Photo 2. View of the open cut developed on the South zone after removal of the 1180 tonne bulk sample. The picture was taken from a point on the 2B vein looking southward. The 1A vein is in the top centre of the photo.

1A vein (or 155 vein) consists of massive white quartz and silicified limestone breccia with up to 10% combined galena-sphalerite-pyrite±chalcopyrite. It occupies part of the 155 fault and has been exposed over approximately 20 metres of strike length. A chip sample across the vein averaged 14.13 g/t Au over 1.3 metres. The 1B vein is a silicified limestone and quartz stringer zone that is parallel to a graphitic limestone bed. It is exposed intermittently over a strike length of about 40 metres and intersects the 1A vein about 20 metres south of the open cut. A chip sample across the zone assayed 27.53 g/t Au over 0.65 metres. The 2B vein (or 16 vein) is located 40 metres north of the 1B vein. It consists of massive white quartz with isolated patches of galena, sphalerite and chalcopyrite. Like the other B veins, it follows bedding and dips 70° west. The vein pinches and swells along its discontinuous 65 metre strike length and is offset by several minor faults. The best chip sample across the 2B vein graded 32.09 g/t Au over 2.4 metres.

The 3B vein lies between the 1B and 2B veins. It is the widest vein on the property and was the focus of the bulk sampling program. The widest and richest segment of the 3B vein occurs in a dilatant zone at its intersection with the 155 fault and an unnamed subvertical fault bearing 080° (the two structures form the west and south walls of the open cut, respectively). The triangle-shaped vein segment, exposed in the floor of the open cut, consists of white quartz and minor carbonate vein material with erratic, semi-massive patches, bands and shoots of galena and sphalerite with lesser pyrite and traces of chalcopyrite (Photo 3). A surface sample, taken across a 4.4 metre width, averaged 31.8 g/t Au along with 63 g/t Ag, 5.8% Pb and 2.8% Zn.

The North zone, located 300 metres northwest of the South zone, comprises two gold-bearing, bedding-parallel veins. The first is a 2-metre wide quartz vein with minor sulphides that becomes a 4-metre wide stringer zone over part of its 50 metres of exposed strike length. The best chip sample across the vein assayed 6.21 g/t Au over 2.4 metres (Savell and Bradish, 1987). The second vein is located about 300 metres northeast of the former and has been exposed in two trenches 50 metres apart along its strike. Chip samples across the sulphide-bearing vein assayed 27.57 g/t Au over 0.25 metre and 17.21 g/t Au over 0.70 metre, respectively.

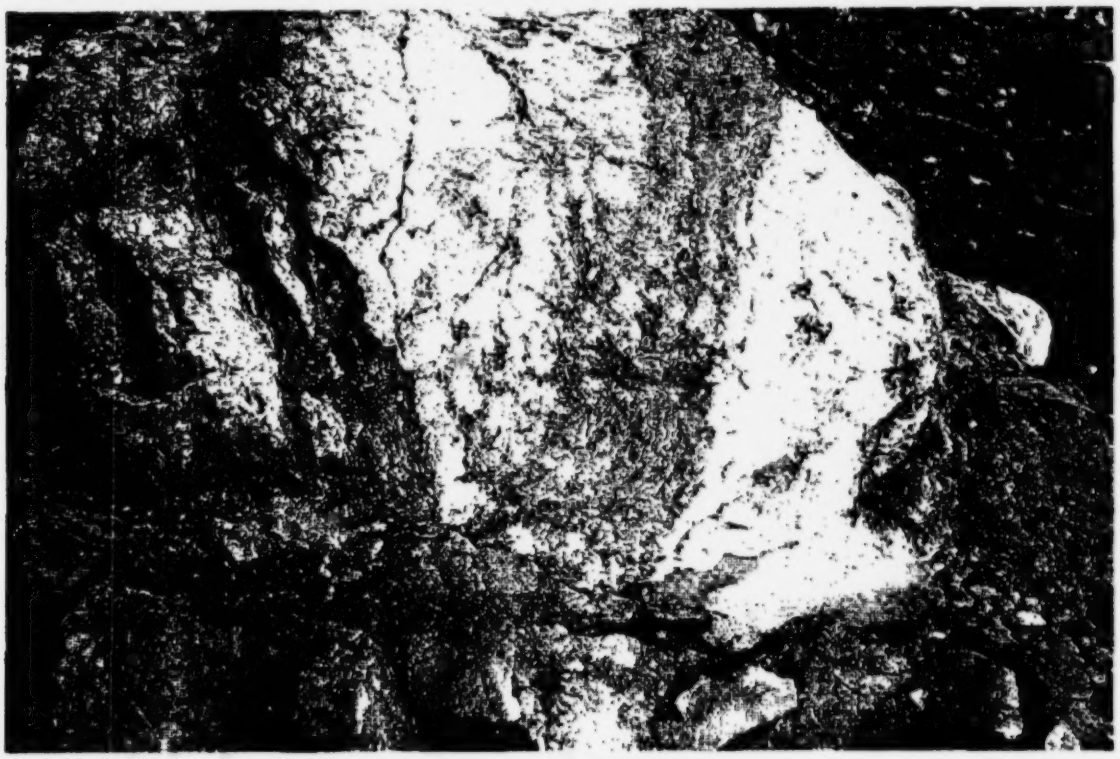

Photo 3. An example of sulphide-rich vein material from the 3B vein. The grey zone in the centre of the quartz -sulphide vein is fine-grained galena. This vein is in contact with the 155 fault (distorted argillite on left side of photo). Width of photo is about 1 metre.

1998 EXPLORATION PROGRAM

A geochemical program consisting of prospecting and soil, float boulder and pan concentrate sampling, was completed within the Dominion Creek drainage. The soil geochemistry sampling confirmed the existence of previously identified anomalies and better defined some of their locations. Importantly, one anomaly was found to be on the east side of Dominion Creek, an area that has received relatively little detailed exploration. The boulder survey successfully outlined three new areas of quartz-sulphide float. One is located 2000 metres upstream and up-ice of the South zone. Another, perhaps the most prospective float anomaly, boulder cluster 4, is located 1700 metres upstream of the South zone and is close to both a multi-element soil anomaly and the year's best pan concentrate assay (*i.e.* sample DCPC 98-14: 1370 ppb Au, 2.4 ppm Ag, 124 ppm Zn, 60 ppm Pb and 86 ppm Cu). Thus the program identified several new exploration targets and strongly suggests that additional gold bearing veins await discovery.

SUMMARY

The Dominion Creek property hosts a series of auriferous quartz-sulphide vein, stringer and replacement zones. Mineralization is lithologically and structurally controlled and occurs within argillaceous limestone of the upper Isaac Formation. The South zone, where west-northwest trending bedding parallel veins intersect northwest trending faults, comprises the highest grade gold mineralization so far discovered. A bulk sample comprised of material from the 2B and 3B veins totaled 1180 tonnes and averaged 14.1 g/t Au.

A number of multi-element geochemical anomalies, similar to those that outline the North and South zones, are located both up-stream and up-ice from known mineralization and warrant detailed follow up.

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A GUIDE TO LOCATING MINERAL-RELATED INFORMATION IN B.C.

www.em.gov.bc.ca/geology

By Larry D. Jones, P.Geo.
Senior Geologist, MINFILE

SUMMARY

During the last few years the Internet has given users the power to access a multitude of linked information sources. The Internet facilitates low cost distribution and quicker availability of our mineral inventory data. The right tool can help you effectively and efficiently retrieve mineral-related information, develop exploration strategies, conduct geoscience research, evaluate the resource potential of an area or plan for land-related decisions.

The purpose of this article is to describe and give examples of the many tools available for locating mineral-related information in British Columbia. Many of the products can be downloaded free from the Ministry of Energy and Mines website or purchased at minimal cost from Crown Publications Inc. in Victoria.

MINFILE contains geological, locational and economic information on over 12,000 metallic, industrial mineral and coal occurrences in British Columbia. MINFILE/www is a simple Internet search and report tool which accesses this database. The MINFILE/pc program is the PC-based tool for searching, viewing, updating, manipulating and extracting information from the database. MINFILE on CD-ROM contains complete text reports in searchable format. Mineral inventory maps are available in hardcopy and many geological maps are published on the Web.

The MapPlace is used for interactive viewing of MINFILE data, along with other Geological Survey Branch and Ministry databases, such as geological maps, geochemical surveys, assessment report index, mineral tenure and mineral potential.

The ARIS and Mineral Titles websites can be searched and used to obtain summary information on mineral exploration Assessment Reports and claim locations, respectively.

Several other products available are summary descriptions of map areas and mining camps; a complete table of deposits with reserves and resources; annual reviews of fieldwork and exploration; links to industry websites; and commodity and deposit type studies.

INTRODUCTION

As technology improves, the amount and complexity of information increases. Clients for mineral-related data would like to access this information quickly and easily. Using and accessing large databases is becoming easier through electronic media, such as CD-ROMs and online access (Internet), transfers (FTP) and downloads. Once relevant information is accessed, choosing the right tool can help to efficiently meet your objectives. This will enable you to put information into a meaningful context. The right tool will allow you to customize, manipulate and adapt this information to specific needs.

You may be interested in basic information on a particular deposit or you may want data on a type of mineralization in an area of B.C. You may want to update the data, add your own data, present the data in a report or table, or create a map to display the data from your query. The tools described below will help you to decide which tool to use to achieve these goals. Hints, examples and direct web links are also given for each of the tools discussed.

The tools and examples operate on a personal computer with an Internet link. A typical configuration would be a Pentium 166 Mhz or higher CPU, 64MB Ram, 4.2 GB hard drive, 8X CD-ROM, 33,600 modem, Windows 95/98, printer (laser or ink jet) and software, including Word for Windows, Excel, graphics package, Netscape or Internet Explorer browser. Plug-ins, which are free from the vendors, include the **Autodesk WHIP!** viewer (*www.autodesk.com/products/whip*) to view AutoCAD maps, **Adobe Acrobat Reader** (*www.adobe.com/prodindex/acrobat/readstep.html*) for reading PDF (Portable Document Format) files and **Autodesk MapGuide Viewer** (*www.autodesk.com/products/mapguide*) to use with The MapPlace.

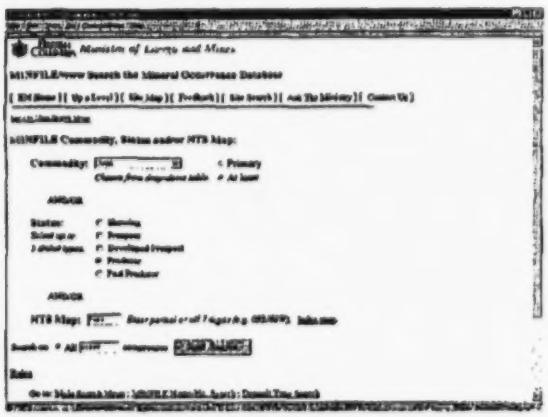
The Ministry of Energy and Mines has recently moved its website to *www.em.gov.bc.ca/geology*; it was formerly at *www.ei.gov.bc.ca/geology*. You can get to the Internet addresses in this article by browsing the Ministry website or directly entering the address into the URL (Universal Resource Locator) window of your browser. Remember to bookmark your favourite sites.

YOUR TOOLS

MINFILE Searches On The Web

www.em.gov.bc.ca/geology/minfile - MINFILE/www

MINFILE/www is a simple Internet search and report tool to access the current database of all mineral occurrences in the province. Simple queries include MINFILE Name, Number, NTS map location, Status, Commodity and Deposit Type. Results are reported in a table format and each occurrence is linked to a Capsule Geology and Bibliography Report. Every search result is linked to The MapPlace website where the data can be displayed in a map format. Results can be progressively queried and a list of occurrences can be saved to a file. This file can be imported into MINFILE/pc and the many report and extract features of this PC-based software can be used. Production and Inventory reports, file extracts, and links to the Assessment Report Index are being added this year to MINFILE/www.



You can use MINFILE/www to answer questions such as: show me all the gold producers in B.C.; give me the information on the Red Bird occurrence in 092H; give me a list on developed prospects with Au skarn deposit type and containing silver. Partial names can also be searched. For example, to find Mt. Polley, enter a wildcard before part of the name, i.e. %poll.

If your browser is setup with the MapGuide plug-in, when you select the longitude/latitude field, a MapGuide window opens with the map centred on the selected MINFILE occurrence. You can manually turn on the MINFILE Status layer, and other layers, using the MapGuide legend. While you are at The MapPlace website, you can go directly to the MINFILE report for an occurrence by double-clicking on the point. See the section below for more information on The MapPlace or visit the website.

While in MINFILE/www you can quickly call up specific MINFILE Numbers. In the Capsule Geology and Bibliography report, you can edit the URL location to retrieve the same report on another MINFILE Number. Simply change the 9-digit MINFILE Number at the end of the URL script. Remember to add ++ for the two spaces in MINFILE numbers without NE, NW, SE, SW, use all CAPITAL letters, and include the '0' for NTS 082, 083, 092, 093 and 094. For example, the following URL address will retrieve the report for Eskay Creek: *www.em.gov.bc.ca/cgi-shl/dbml.exe?template=/mf/search/search&mode=capbib&minfilno=104B++008*. You can bookmark this address and then edit the last 9 characters to go directly to a new MINFILE report. For example, changing *104B++008* to *092INE038* will take you to the Getty North deposit report.

A few industry web page links are listed in the MINFILE bibliography, with the designation WWW. You can cut and past the URL script into your browser to go to the Company website. See the section called **Industry Web Links in MINFILE and 1998 Mines Directory** below for access to industry websites.

If you want quick access to prevalent parts of the MINFILE data, using commonly requested queries, pay a visit to MINFILE/www.

MINFILE/pc, Manuals and Data

www.em.gov.bc.ca/geology/minfile/minfpc.htm

The MINFILE/pc program is the desktop computing tool for searching, viewing, updating, manipulating and extracting information. It is a FoxPro DOS application than can run as a DOS application in a Window on your computer.

MINFILE/pc, through 12 menu-driven screens, enables you to search the MINFILE Database on a variety of exploration and/or geological parameters. MINFILE/pc can send the data, in 12 formatted reports, to the screen, a file or a printer for viewing. The data-entry function allows you to alter or add data to the MINFILE database. The data can be easily transferred between computers and exported for use in other programs and mapping packages. MINFILE/pc can be ordered free of charge or downloaded. Help Desk support is available from the MINFILE Project Staff. You can find the most common questions, problems, and solutions for using MINFILE/pc at our Frequently Asked Questions (FAQ) site at: *www.em.gov.bc.ca/geology/minfile/manuals/user/appdxk.htm*

Recent program features include: handling of location data in both NAD 27 and NAD 83 datums; output files and reports display either datum; new region fields; the ability to enter world-wide locations; new

extract files, in ASCII, dBASE and Worksheet formats; and longitude/latitude in decimal degrees. System configuration changes include the ability to modify Code Tables; select your own text editor; select datums; specify coordinate working areas; and password security to restrict access to read-only.

If you want access to all the data, have powerful searching capability, have flexible reporting and exporting, or modify and add data, use MINFILE/pc. You may want to add deposits from areas outside B.C., such as a group of deposits from the Yukon. The Region table can be used to tag a group of deposits for later manipulation, such as assigning the group to a particular mining camp. The Region table can be modified to add your own keywords. Using the new anomaly status, you can add geochemical or geophysical anomalies. The Exploration Projects module can be used to create your own exploration database and attach a group of deposits to a project.

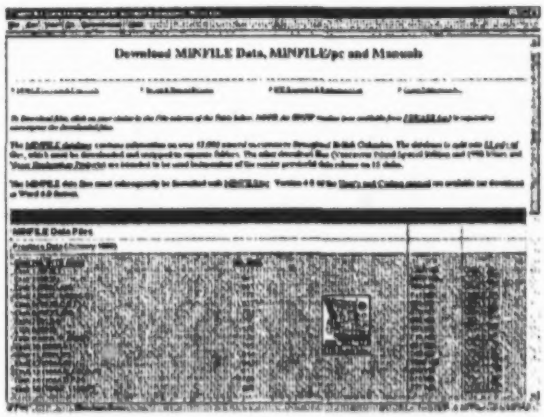
MINFILE/pc provides exports to other software, such as Excel and Word. Georeferenced files can be exported for use in Geographical Information Systems (GIS) and mapping systems such as ArcInfo and AutoCAD. The most useful export - the *mineral.dbf*, *reserve.dbf* and *product.dbf* files, includes a summary of the occurrence information, reserves and production. The definition of these files is found at *www.em.gov.bc.ca/geology/minfile/manuals/user/appdxl2.htm*.

The User's Manual contains information on installing, operating, using, and customizing the MINFILE/pc program and database files. The appendices contain basic DOS information, code tables, the database structure, help sections and computer memory information. The MINFILE/pc V. 4.5 User's Manual (Information Circular 1997-2) is currently being updated; a draft version is available for viewing on the Web.

The Coding Manual, Version 4.5 (Information Circular 1996-5) is a guide to data specifications and codes used in MINFILE. This 110-page manual is used by geologists to input information into the database. A new version of this manual is being updated; a draft version is available for viewing on the Web. Coding Cards are available as PDF files.

Version 4.0 (January 1996) of the User's and Coding manuals (excluding some appendices) may be downloaded from the Web or you can obtain the disk versions, which are in Microsoft Word 6.0 format, from the MINFILE staff. You can also view the manuals at: *www.em.gov.bc.ca/geology/minfile/products/manuals.htm*.

The complete MINFILE database of more than 12,000 metallic mineral, industrial mineral and coal occurrences is on 15 diskettes. The data includes: names; commodities; status (showings to producing mines); location (NTS map, longitude/latitude, UTM, elevation and Mining Division; mineralogy and alteration; deposit character, classification and type (based on B.C. Mineral Deposit Profiles); hostrock (lithology, stratigraphic names and ages); geological setting (tectonic belt, terrane, physiographic area and metamorphism); inventory (assays, reserves/resources and production); capsule geology and work history; and references and publications. The data disks are available for $75.00 from Crown Publications Inc. or as a free download from *www.em.gov.bc.ca/geology/minfile/minregis.htm*.



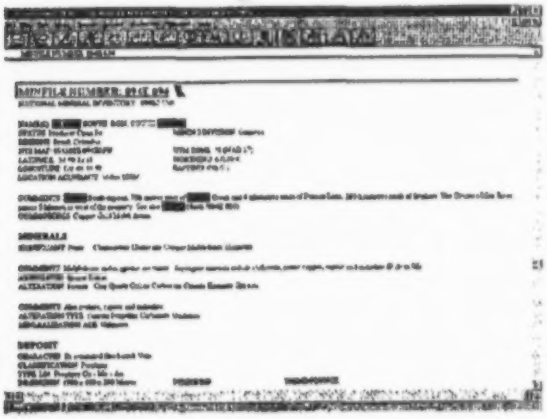
BC MINFILE Reports on CD-ROM

www.em.gov.bc.ca/geology/minfile/products/cd-rom.htm

BC MINFILE on CD-ROM is a complete record of all occurrences in B.C. in report format. Using Folio VIEWS Infobase software, you can quickly search the information stored in the MINFILE Master and Production reports. No extra software is required. With Infobase you can create customized word searches and search the text on a single term or a string of words. The program is fast, efficient and easily operated. You can also print and save to a variety of word processing formats.

The reports, encompassing almost 24,000 pages, contain all the data in MINFILE. This includes extensive information on location; mineralogy and alteration; geology and hostrocks; assay data, reserves and production records; references and other information on each occurrence. Each report also includes a text description of the geology and setting of each occurrence. The data is current to December 1998. This year's release of the CD-ROM also includes MINFILE Number and Name indexes. MINFILE/pc is used to generate the Master and Production reports from the digital MINFILE Database.

A description of the Folio VIEWS Infobase along with a tutorial and help document are available on the CD-ROM. This CD-ROM is available for $100.00 from Crown Publications Inc. The CD-ROM was produced by Hyperborean Productions Inc. (*www.hyperborean-web.com*), based in Whitehorse, Yukon.



If you would like to quickly access the 24,000-page report of the complete MINFILE, then the CD-ROM is for you. You can enter simple or complex queries, instantly see the number of hits, and quickly go to the result. For example, a search on the word 'tailings' results in 109 hits. A search of 'gold and tungsten and no silver' results in 62 hits. The CD-ROM is a powerful tool for searching commodity combinations and mineral assemblages. By using the Infobase query language, you can search the entire report or part of the report for single words, phrases, or word patterns. Using the query operators, you can also create relationships between words to find ideas. There are nine search templates provided, each allowing you to focus your search on a particular section of the Master Report. For example, using the Inventory category there were 26 hits of deposits with calculations reported in the year 1998.

Aside from the ability to save your results as a word processing document, the CD-ROM does not allow flexible reporting and exports of your results like MINFILE/pc does. For example, a file useful for plotting cannot be created easily. However, the CD-ROM allows searching of the capsule geology and bibliography, whereas MINFILE/pc does not. MINFILE/pc uses menu-driven searches, while the CD-ROM uses a query language, which requires some understanding. The CD-ROM is particularly handy if you want a quick digital copy of a nicely formatted MINFILE report. A similar CD-ROM is available for the Yukon MINFILE.

MINFILE Maps

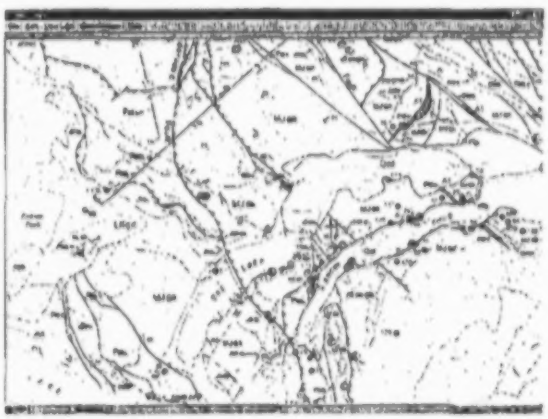
www.em.gov.bc.ca/geology/minfile/products/minmaps.htm

MINFILE maps display mineral occurrences on a topography and geology base. In the map package is a summary description of the map area, including an overview map, selected references and tabular indexes. The 101 MINFILE maps are also available on microfiche for $10.00 per set. Paper copies of the maps, which may be purchased for $5.00 per map area, are plotted at either a 1:100,000 or 1:250,000 scale depending on the density of occurrences on the map. The fiche and maps are available from Crown Publications Inc. These maps are useful as an inexpensive portable hardcopy to quickly see the location of occurrences and to mark-up with your exploration strategies.

Geological Maps On-Line

www.em.gov.bc.ca/geology/bedrock/mapsonline/mapsonline.htm

Using the free WHIP! Plug-in, you can view geological maps on-line. WHIP! displays drawings inside your web browser using the Drawing Web Format (DWF), a lightweight vector file format that preserves the security and precision of original AutoCAD .DWG files, while ensuring the speedy display of drawings. You can zoom in, turn layers on and off and save the on-line maps as .DWF, .BMP and .DWG files. For additional information on these products, see Bedrock Mapping at: *www.em.gov.bc.ca/geology/bedrock.*



Mineral-Related Data on The MapPlace

www.em.gov.bc.ca/geology - The MapPlace

The MapPlace gives access to many of the BC Geological Survey Branch and other Ministry data sets. With a free plug-in (Autodesk MapGuide Viewer), you can interactively view and download datasets. You have the ability to create your own maps using these periodically updated datasets. Reports can be created from selected themes and objects. Examples of theme

maps are GEOCHEMISTRY, which is a map highlighting the Regional Geochemistry database and MINERAL TITLES, which is a map with geographic information and the mineral title information. The most common map is GENERAL, which includes virtually all available datasets.

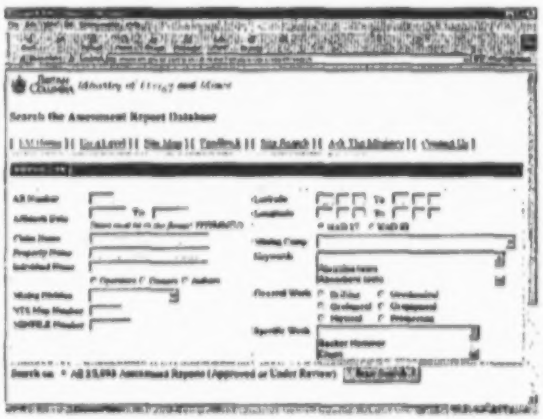
The EXPLORATION ASSISTANT features the ability to perform detailed selections of information to display on the map. Searchable data includes: Mineral Potential Tracts; MINFILE (commodities, names, and deposit types); geology (age, lithology and terrain); and names and anniversary dates of claims. The following are examples of queries: find a particular settlement, such as Gold Creek; display areas favourable for garnet skarns; show the location of the Samatosum deposit; plot all Jade occurrences; plot the Placer deposits; zoom into an area and display Cretaceous age sedimentary rocks within any terrane; find the Tam claim; display all claims in an area with an anniversary date in the next 40 days.

With The MapPlace you can download and directly link to many of the data sources. These include Digital Geological Maps, Mineral Potential information, Mineral Titles, MINFILE, ARIS, Regional Geochemical Surveys, Geological Survey of Canada databases, map indexes, and Terrain Maps.

ARIS/www

www.em.gov.bc.ca/geology/Aris

The British Columbia Geological Survey Branch has approved and transferred to microfiche more than 25,500 mineral exploration assessment reports filed by the exploration and mining industry since 1947. These reports provide information on geological, geophysical, geochemical, drilling and other exploration-related activities throughout B.C. ARIS (Assessment Report Indexing System) is a computer-based system that indexes all these reports. Paper copies of the index, maps, and original and/or microfilmed assessment reports can be viewed at selected provincial government offices throughout the province. Assessment reports can be purchased as photocopies and microfiche. ARIS data can be interactive viewed along with other GSB databases at The MapPlace. To download the ARIS data free of charge see the ARIS website.



A significant addition to the ARIS website, is the ARIS/www search engine. Searches include affidavit date, claim name, mining division, property name, operators/owners/authors, NTS map number, MINFILE number, latitude/longitude, mining camp, keywords, general work such as drilling, and specific work such as silt sampling. A search will result in a table of hits. The Assessment Report number field links to a summary of that report; the NTS maps link to a location sketch map of the area; MINFILE entries, if any, link to the MINFILE Capsule/Bibliography report; and the Longitude/Latitude links to The MapPlace.

Mineral Tenure Database Search

www.em.gov.bc.ca/mining/titles

This site provides you with details on mineral tenures and Free Miners in British Columbia. Search options include tenure number, free miner, tenures owned by a person or company, tenures staked by a person, tenures on a specific map, tenure by claim name or tag number, lot by lot number and land district. You can view mineral tenures on a map at The MapPlace. Once here, double clicking on a mineral tenure will link you to the Mineral Titles complete database. The Mineral Tenure site also has links to other mineral title information, such as guides to locating mineral claims, gold commissioner's offices, information letters, Mineral Tenure Act, Coal Act, and other publications.

Geochemical Inventory

www.em.gov.bc.ca/geology/geochinv

Geochemical inventories are a powerful mineral exploration tool and an important source of information for land-use and environmental assessments. This website directs you to various geochemical databases collected and maintained by the Geological Survey Branch. They include the Regional Geochemical Survey (RGS) Program, Till Geochemistry Surveys and Lake Sediment Geochemical Surveys.

The RGS program develops, maintains and disseminates a comprehensive geochemical database consisting of stream sediment, moss sediment, lake sediment, stream water and lake water analytical data plus field site observations. Data from joint Federal-Provincial reconnaissance-scale geochemical surveys have been systematically collected, compiled and published annually since 1976. You can use this high-quality baseline geochemical data to outline regional geochemical trends, assist mineral potential evaluation and aid regional metallogenic studies and geologic interpretations.

Till geochemistry surveys are targeted at regions of high mineral potential where glacial sediments cover and obscure the underlying bedrock. Till geochemical anomalies identify areas where glaciers eroded mineralized bedrock and redeposited the mineral debris in down-ice dispersal trains. They provide a cost effective target for mineral exploration programs in drift-covered terrains.

The RGS data and maps can be purchased at Crown Publications Inc. or the raw data can be downloaded from The MapPlace.

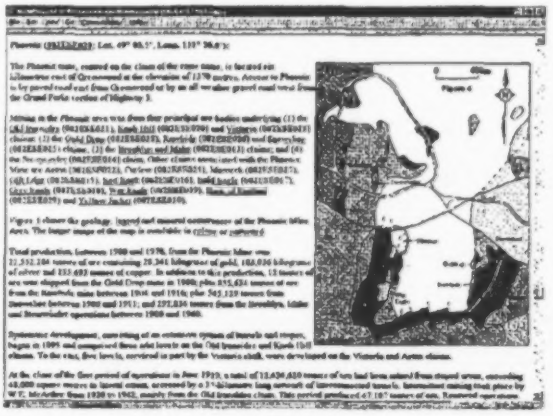
RECENT SPECIAL PRODUCTS

NTS Summary Sheets and Mining Camps

www.em.gov.bc.ca/geology/minfile/products/prodlist.htm

The MINFILE website provides access to 88 summaries of all the NTS map areas covered by the MINFILE database. These briefly describe the geology of the map area, highlighting the significant occurrences. Most of the summaries include a list of references, geological legend and sketch map showing a plot of the occurrences. Deposits mentioned in the text are linked to the on-line capsule and bibliography report. You will find these summaries to be useful introductions to the map areas. These are updated periodically with new links.

If you are interested in mining camps in British Columbia, there are a few articles posted on the Internet. These include the Beaton-Camborne (*www.em.gov.bc.ca/geology/minfile/mapareas/beaton.htm*), Bridge River (*../bridge.htm*), Greenwood (*../greenwd.htm*), Slocan City (*../sloccity.htm*), and Slocan (*../sloccov.htm*) mining camps. These articles include mining histories, geological settings, mineral deposit descriptions, metallogeny discussions, photos, geology and underground plan sketch maps, production tables and extensive reference listings.



Vancouver Island Special Edition

www.em.gov.bc.ca/geology/minfile/products/vanisl.htm

This disk, updated to January 1999, documents all 1421 metallic mineral, coal and industrial mineral occurrences on Vancouver Island and adjacent islands. The website shows a plot of MINFILE occurrences with links to NTS map area summaries, reference lists, and mineral occurrence plots. Included in the set are 124 occurrences described in a publication by Rick Hudson (1997): A Field Guide to Gold, Gemstones & Mineral Sites of British Columbia, Volume I, Vancouver Island, Orca Book Publishers. This field guide describes geology and mining history of the Island, prospecting techniques, rock and mineral identification, and brief site descriptions with location maps. The Vancouver Island Special Edition disk is downloadable or is available for $7.50 from Crown Publications Inc.

Reserves/Resources Inventory

www.em.gov.bc.ca/geology/minfile/products/res_res.htm

This 192-page report includes a 113-page table of 808 mineral deposits in British Columbia with known reserves and resources. The inventory, which is sorted by deposit name, includes the tonnage and grade of metallic minerals, industrial minerals and coal occurrences. Data for each deposit include name, MINFILE number, geographic location, NTS map, status, mining division, deposit type, zone name, year, reference, comments, tonnage, category, grade and commodity. Various reports

and sorted tables are included: a Commodity Legend, a sample Master Report, an Alphabetical Index, a MINFILE Number Index, a table of Mineral Deposit Profiles, and a Deposit Type Index. The tables were generated from MINFILE/pc V. 4.5 and reflect the status of the MINFILE database as of January 1999. This Open File is a handy hard-copy reference to British Columbia's rich mineral endowment. The annual publication is available for $20.00 from Crown Publications Inc. Part of the report is available for viewing on the Web.

1998 Mines & Exploration Projects, Open File 1999-1

www.em.gov.bc.ca/geology/minfile/products/mine1998.htm

This annual publication contains 2 maps at 1:2,500,000-scale; a separate MINFILE data disk is available. The disk provides data on 117 deposits including operating mines, projects in the Environmental Assessment Review, projects that have received Mine Development Certificates, exploration highlights and advanced exploration/development projects in British Columbia. The maps show the location of each of the 117 deposits contained in the dataset.

In 1998, a total of 60 deposits (metallic mineral, industrial mineral and coal) were being mined in the province of British Columbia. Kemess South started production and Blackdome was reopened in 1998. Several small high-grade projects continue to produce, or plan to produce, using custom milling arrangements. A number of advanced projects are in the Environmental Assessment Review, with several in the pre-feasibility stage, as well as some receiving Certification or a Mine Development Certificate. The maps are available for $10.00 and the disk for $7.50 from Crown Publications Inc. A simplified map of Operating Mines in BC is available at: *www.em.gov.bc.ca/geology/general/minedir/minemap98.htm*.

BC Mineral Exploration Review

www.em.gov.bc.ca/geology/general/reviews

This annual publication provides an overview of mineral exploration activities in the Province of British Columbia for a given calendar year. It contains statistical information, tables, illustrations and location maps which summarize significant exploration and development projects in the province. The report documents mineral exploration expenditures, active exploration areas and the companies involved. Exploration Review 1998 is available on the Web as a PDF document.

Geological Fieldwork 1998

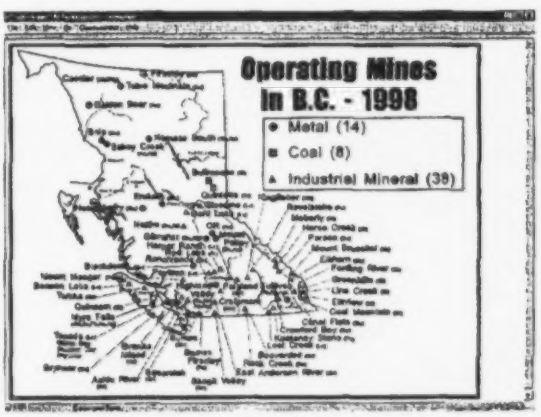
www.em.gov.bc.ca/geology/Publications/freepubs/fldwk98/toc.pdf

This PDF document is an annual publication and contains reports of Geological Survey Branch activities and projects during the year. The Branch's field surveys in 1998 concentrated on under-explored frontier regions and on areas with established mining infrastructure.

1998 Mines Directory

www.em.gov.bc.ca/geology/general/minedir

This address list of active mines and companies is published yearly. The directory includes metal mines, coal mines, industrial mineral operations and mineral products. The 1998 edition on the Web contains active links to company pages and to the MINFILE database. The directory is also included with Open File 1999-1, 1998 Mines & Exploration Projects. A simplified map of Operating Mines in BC is available on the Web.



Industry Web Links in MINFILE

www.em.gov.bc.ca/geology/minfile/search/wwwsite.htm

The MINFILE Bibliography includes mining industry web links. A summary of these link are available as a table on the Web; attempts are made to keep them current. The table is sorted by MINFILE number or name, which are also linked to the Capsule Geology/Bibliography report. Good summaries of several developed deposits can be found. Currently the table links over 55 properties to industry websites.

New Occurrences in MINFILE

www.em.gov.bc.ca/geology/minfile/search/newocc.htm

This site tracks major updates and new additions to the MINFILE database as it changes and grows. The table will list these additions beginning from the last major publication of the database, for example Roundup in January 1999. The table includes MINFILE Number,

Name, Status, Commodities, NTS Maps, Latitude, Longitude, Deposit Type and Date Added. The MINFILE number is actively linked to the Capsule Geology/Bibliography report and the latitude/longitude is linked to the occurrence location in The MapPlace. Check out this site to view the new Bear Paw Ridge, Lady Bug and Goldstrike occurrences.

Property File in Victoria

www.em.gov.bc.ca/geology/minfile/propfile.htm

Property File contains hard-copy reports and maps that are generally unavailable elsewhere. These documents, which can be extremely valuable to researchers, typically include unpublished reports; theses and papers; field notes; company prospectuses and pamphlets; historical information; geochemistry, geophysics and drill information; claim maps, sketches of workings and photographs. Property File also contains general information on each NTS area, the National Mineral Inventory information, topographic maps and some work histories. The research material is indexed by MINFILE number and cross-referenced in the MINFILE Database. Property File may be viewed at: Ministry of Energy and Mines Library, Main Floor - 1810 Blanshard Street, Victoria, BC; Tel: (250) 952-0583.

Silver Deposits in BC, Open File 1998-10

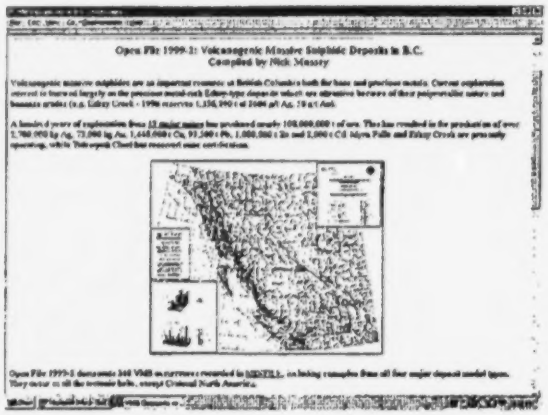
www.em.gov.bc.ca/geology/publications/summs/of9810.htm

This Open File briefly reviews the abundance and diversity of silver lode deposits in British Columbia. The report includes summary tables of reserve and production data and deposit types for close to 300 major producers, past producers and developed prospects. The location of these deposits, their current status with respect to production, and deposit type are shown on a map.

Volcanogenic Massive Sulphide Deposits of BC, Open File 1999-2

www.em.gov.bc.ca/geology/publications/summs/of992.htm

The map (1:2,000,000 scale) and the accompanying databases (in dBase and MS-Excel formats) document some 248 volcanogenic massive sulphide occurrences in British Columbia. The mineral occurrences are derived from MINFILE with editorial input from Geological Survey Branch staff. The mineral occurrences are classified into the following deposit types: Kuroko (173), such as Myra Falls and Tulsequah Chief; Besshi (55), such as Goldstream and J & L; Eskay (10), such as Eskay Creek; and Cyprus (10), such as the Anyox deposits. The tables provide a listing of all occurrences as well as production figures. Two charts illustrate the distribution of the four deposit types by tectonic belt and lithostratigraphic terrane.



The Open File is available from Crown Publication Inc. for $25.00. Copies of the data files and a plotfile (~10Mb) for the map are available for download from the Web at *www.em.gov.bc.ca/geology/Economic%20Geology/MetallicMinerals/vms/vms.htm*.

Prospective Areas in BC for Intrusion-related Gold-Tungsten-Bismuth Veins, Open File 1999-3

www.em.gov.bc.ca/geology/publications/summs/of993.htm

Gold-quartz veins related to Cretaceous age granitic intrusions in Alaska and the Yukon have created the Cordillera's latest gold rush. The initial interest was sparked by the opening of the Fort Knox open-pit mine in the Fairbanks District in Alaska and discoveries in the Yukon, such as Dublin Gulch and Brewery Creek. The discovery of the Pogo gold-quartz vein in Alaska has attracted more exploration activity. Similar mid-Cretaceous and other granitic intrusions are found in British Columbia. The map (1:2,000,000 scale) shows their locations, identifies known intrusion-related gold-tungsten-bismuth mineralization and highlights prospective areas for exploration. A diskette contains dBASE files with selected mineral occurrences. The Open File is available for $25.00.

Mineral Deposit Profiles

www.em.gov.bc.ca/geology/Economic%20Geology/MetallicMinerals/mdp/mdphome.htm

The British Columbia Geological Survey has been working on descriptions of many of the mineral deposit types that can be found in the Canadian Cordillera. The descriptions (called profiles) provide concise overviews of different deposit types. You can use the profiles to review the key characteristics of different deposit types including typical examples, tectonic setting, mineralogy, alteration, genetic models, associated deposits, typical grades and tonnages and exploration guides. Sixty

profiles for metal and coal deposits have been published (Open Files 1995-20 and 1996-13). Many of these are posted on the Web.

You can find a discussion on Coal in BC at: *www.em.gov.bc.ca/geology/Economic%20Geology/coal*. Other interesting articles at the Economic Geology website include New Mineral Deposit Models for the Cordillera, Characteristics of Gold Skarns, and Metallogeny of Volcanic Arcs (abstracts). Contact Dave Lefebure, Tel: (250) 952-0404, or visit the Web site for more information.

Web Search Engines

There are many web search engines available that can lead you to company profiles, new releases, annual reports, environmental studies and project summaries. For example a search of 'eskay creek' using *Scrub The Web* (*www.scrubtheweb.com*) led to a paper entitled *ARD Assessment Program from Exploration to Operation Case Studies from the Eskay Creek Mine*. And the exact phrase 'golden bear mine' gave 56 matches on *Hot Bot* (*www.hotbot.com*).

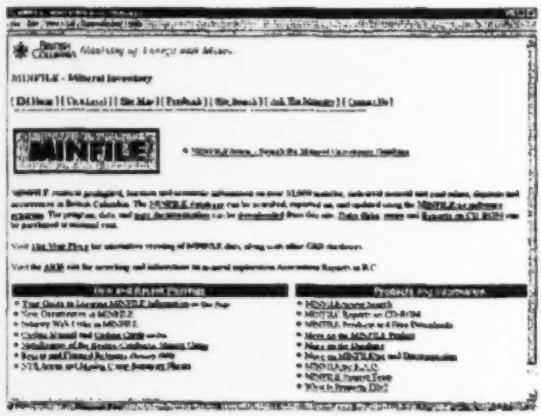
Custom Searches, Datasets and Support

contact MINFILE staff

The MINFILE staff are always ready to help you with any of our programs and products. We can provide you with custom datasets and searches. Examples of past requests and inquiries include: production tables for deposits located within the Kootenay terrane; lists of copper and gold deposits in Jurassic rocks; list of all jade and soapstone deposits in B.C.; where did Sebakwe operate in the early 1900s; number of producing mines operating in each of the last 6 decades; location of the magnetite suppliers in B.C.; a plot of mineral occurrences within the Cassiar-Iskut-Stikine Land Resource Management Plan; non-published documents available for the Huckleberry area; number of occurrences and assessment reports existing within a Treaty negotiation area; document of MINFILE occurrences associated with the sale of Reverted Crown grants; output from The MapPlace of a colour plot of mineral potential, mineral occurrences, rivers, roads and claims for the New Polaris region; a list of producers and past producers suitable for recovery of minerals by leaching tailings. These show the diversity of our various tools for retrieving mineral-related information.

CONCLUSION

The Internet is a dynamic tool for accessing, displaying and distributing our mineral-related databases as they grow and are updated. The Ministry will continue to be innovative in implementing these tools to aid you in your quest for information.



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Most publications of the BC Geological Survey are available for purchase through:

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